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ANTHROPOLOGY

ODONTOPATHIES IN A BRONZE AGE HUMAN POPULATION FROM CÂNDEŞTI (VRANCEA COUNTY, ROMANIA)

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The present study focuses on the odontopathies identified in a sample of human skeletons dating from Middle Bronze Age (Monteoru Culture, 1550–1300 BC), discovered in the necropolis of Cândeşti (Vrancea county, Romania). The analysed material comes from 10 subjects – seven males (two adults and five matures), two females (one adolescent and one mature) and one child *(infant II*). The human skeletons from which the teeth analysed in this paper come are in the custody of the "Olga Necrasov" Center of Anthropological Research, Romanian Academy – Iași Branch.

The teeth were analysed on a Carl Zeiss Stemi 2000-C stereomicroscope with a Canon Power Shot SX70 HS attached. This study provides new evidence of odontopathies, in an ancient population of Romania. The following pathologies and anomalies were identified at dental level: radicular remains and edentia (one case for each), dental caries and dental calculus (three cases for each), dental abrasion and dental enamel hypoplasia (four cases for each).

Keywords: odontopathies, human remains, Middle Bronze Age, Cândeşti (Romania)

1. INTRODUCTION

Dental tissues are the hardest in the body and, due to their biochemical composition, they are able to resist destruction and taphonomic conditions better than bones. The tooth is, therefore, an excellent material for paleoanthropological investigations (including morphometrics, genetics, stable isotopes, etc.). Human dentition provides many details beneficial in skeleton analysis [39,28,3]. Teeth are a rich "archive" that provides information about the health and nutritional status, individual and collective ancient habits, and lifestyles [35,32]. Observations on tooth morphology and microstructure contribute to the knowledge of the human biological and cultural diversity, as well as to local and systemic diseases [25]. Oral pathologies can be used as markers of fundamental changes in human ecosystems and help evaluate the cultural, biological, and ecological aspects of life in the past. Tooth wear provides information about the diet, but also about some type of production activities and social division of labour (*i.e.* the tooth non-alimentary wear) [39,28]. Study of the use of teeth as instruments in a wide area of activities not related to diet can be improved and amplified by ethnographic research [26,6].

Analysis of skeletal lesions resulting from infectious disease on prehistoric materials offers information about the interplay of many factors, such as disease, diet, ecology, social structure, warfare, settlement pattern, plant and animal domestication, sanitation level, immunological resistance, physical and psychological stress [27].

The most common palaeopathological conditions of jaws and teeth include fistulas, ante-mortem loss of teeth, stones, caries, hypoplasia, hyperkementosis, opening of the pulp chamber and alveolar resorption [8]. Infectious diseases, such as caries, are relatively common affections observed in archaeological populations, whereas the jaw degenerative diseases, including ante-mortem tooth loss, usually appear in elders. Development problems include enamel hypoplasia and genetic anomalies [37]. Enamel hypoplasia is used as a nonspecific indicator of stress and malnutrition, being considered a valuable source of information for the anthropological research of ancient populations [48,50].

The present study intends to analyse the odontopathies identified in 10 human skeletons dating from Middle Bronze Age (Monteoru Culture, 1550–1300 BC), discovered in the necropolis of Cândeşti (Vrancea County, Romania). The discovery and excavations of the ample necropolis of Cândeşti (N45.539172, E27.073576) (Fig. 1/a, b) were carried out between 1968 and 1982, under the coordination of archaeologist Marilena Florescu. Over 400 human skeletons were found, providing a rich archaeological material [14]. This large sample of human skeletons has been previously studied paleodemographically and morphometrically by Georgeta Miu in her PhD thesis [33]. According to this study, the population of Cândeşti presents a typological polymorphism belonging to the Europoid group [33]. Nowadays, part of this sample is in the custody of the "Olga Necrasov" Center of Anthropological Research, at the Romanian Academy – Iași Branch.

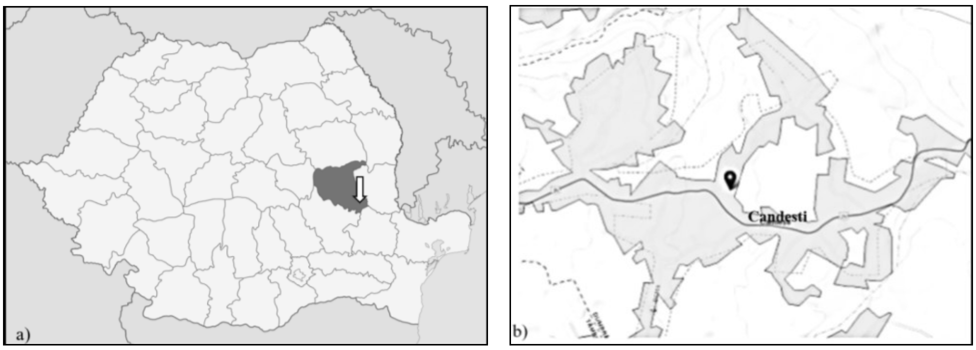

Fig. 1. Location of the Bronze Age necropolis of Cândești (Vrancea County, Romania): general (a); detail (b); (Source: http://ran.cimec.ro/).

2. MATERIAL AND METHODS

In the present study, we re-evaluate only a small part of the skeletal remains from Cândeşti (Vrancea county, Romania) represented by 10 subjects, as follows: seven males (two adults and five mature), two females (one adolescent and one mature) and one child *(infant II)*). Data on age at death and sex was taken from the previously paleodemographic analysis achieved by Miu, 1999 [33].

Since teeth are considered human remains very well preserved over time, they can provide information about the health state or lifestyle of a past population. In this study, the odontopathies are evaluated by macroscopic observations and stereomicroscopy.

In order to identify dental pathologies, we cleaned the teeth (found in the alveoli or post-mortem fallen from the alveoli) using a soft brush, to eliminate the particles that would have impeded visual inspection. The teeth were prepared for stereomicroscopy by removing contaminants from the dental surface using ethanol, then analysed on a Carl Zeiss Stemi 2000-C stereomicroscope with a Canon Power Shot SX70 HS attached.

Dental caries (when perforations affected the dentin) were recorded based on their position and gravity [34].

Dental calculus or plaque (grey-white mineralized plaque composed primarily of calcium phosphate) is firmly attached to the dental surface. Depending on the positioning on the tooth crowns or exposed roots, dental calculus can be supragingival or subgingival [52]. Calculus should be reported as “0” (absent), “1” (small amount), “2” (moderate amount), “3” (large amount) [5].

The degree of dental wear was stated according to the method proposed by Smith and Knight [42]. Cases of edentia (partial or total absence of teeth in the oral cavity due to falling after eruption caused by several factors) were identified [23].

Enamel hypoplasia was analysed according to the DDE Index, even if other registration methods have been also considered. The severity degree was established according to the method proposed by King, Hillson and Humphrey [24]. Recording of the hypoplasia type has considered four main categories, namely: pits, horizontal ditches, vertical ditches, and areas wholly devoid of enamel [55]. Localization of enamel hypoplasia was observed on three anatomic dental surfaces: facial, lingual and occlusal. On the crown of each tooth, it was established whether the hypoplasic defect is singular or multiple, well-delimited or diffuse [55]. Estimation of the age at which the hypoplasic defect first appeared was based on the method proposed by Goodman, Armelagos and Rose [15]. For each hypoplasic tooth, the digital caliper was used for measuring the following parameters: distance between the cement-enamel junction and the center of the hypoplasic defect; distance between the cement-enamel junction and the occlusal margin. The obtained values have been subsequently introduced in the regression equation: Age at formation = age at crown completion – [(years of formation/ crown height) × defect height (from CEJ)].

3. RESULTS AND DISCUSSION

As previously mentioned in the presentation of the study material, the analysed teeth belonged to 10 human skeletons – one child (*infans II)*, one female adolescent, two male adults and six matures (five males and one female). All teeth are well preserved. We identified dental caries, dental calculus, dental abrasion, radicular remains, edentia and dental enamel hypoplasia (Table 1).

Table 1

Odontopathies identified in the analysed sample

Skeleton	Sex and age	Odontopathies
M 8	♂, 35-40 year-old	*– caries* *– supragingival dental calculus* *– edentia subtotal*
M 138	♂, 35 year-old	*– supragingival dental calculus*
M 302	♂, 40–45 year-old	*– dental abrasion*
M 313	*indeterminable,* 11–12 year-old *(infans II)*	*– dental enamel hypoplasia*
M 331- B	♀, 40–45 year-old	*– caries* *– dental abrasion* *– radicular remains*
M 487	♂, 45–50 year-old	*– caries* *– dental abrasion*
M 592	♂, 20–25 year-old	*– dental enamel hypoplasia*
M 672	♂, 35–40 year-old	*– dental abrasion* *– dental enamel hypoplasia*
M 683	♀, 17–18 year-old	*– supragingival dental calculus*
M 691	♂, 20–25 year-old	*– dental enamel hypoplasia*

DENTAL CARIES

Even though the caries are the most common dental pathologies observed in modern populations, they are seldom observed in archaeological human remains, probably because of the significantly lower consumption of sugars and processed foods. It has been stated that the exposure of dentin renders the individual more susceptible to caries [29]. Emphasis has emerged on the difference in caries frequency among human populations, as an indicator of varying food resources, and nutritional distinction between hunter-gatherers and agriculturalists [1], [1,38,51,10,19,30]. Caries frequency is low among hunter-gatherers and more than twice as high among agriculturists. Both malnutrition affecting tooth development and higher concentrations of carbohydrates in the diet have been invoked to explain the higher caries frequency in agricultural populations [34].

Dental caries has a multifactor etiology, presenting various degrees of gravity, from opaque stains to large cavities affecting the teeth [36]. Bioarchaeological studies use the incidence of dental caries as a nonspecific indicator of the eating behaviour [49]. Powell (1985) indicates that the main factors influencing dental caries are: environmental factors (oligoelements present in food and water), pathogenic agents (bacteria causing the disease), other exogenous factors (diet, oral hygiene) and endogenous factors (teeth shape and structure) [35]. As to the incidence of dental caries, some researchers noticed that it is much higher in female subjects as opposed to males [47], due to the fact that men eat bigger amounts of non-cariogenic foods, whereas women eat larger quantities of cariogenic carbohydrates [49].

In this study, dental caries were observed in three subjects, more specifically two males aged between 35 and 50 years (Fig. 2; Fig. 4/a, b, c, d, e) and one female aged 40–45 years (Fig. 3/a, b). In two of the cases, dental caries affected the upper and lower second molars – M2 and the lower third molar – M3, whereas in one case it affected the upper second premolar – P2. Different types of caries have been identified: interproximal, cervical and root caries (Figs. 1–4).

DENTAL CALCULUS

Calculus (calcified plaque) frequently traps food remains and plant phytoliths, so that it can be useful in dietary reconstructions. Calculus sample should be removed from teeth and curated for future microscopic and chemical analyses [7].

Depending on its localization, either on the tooth crown or on exposed roots, there are two forms of calculus: supragingival and subgingival, respectively [52]. According to Waldron (2009), there is an inverse relationship between calculus and caries, since calculus needs an alkaline environment to develop, whereas caries develop in an acidic environment, which leads to the logical conclusion that the two processes are incompatible [52]. Dental calculus appears most frequently on the teeth located closest to the salivary glands (especially on mandibular incisors and maxillary molars) [37]. The supragingival dental calculus was identified in three subjects, more specifically in two mature males aged between 35 and 40 years (Fig. 5/a, b; Fig. 7) and one adolescent female of 16-17 years (Fig. 6/a, b, c, d).

DENTAL ABRASION AND RADICULAR REMAINS

Tooth wear is a normal biomechanical process whereby dental tissues are progressively diminished through frictional contact with other teeth (dental attrition) or food, foreign particles contained in food, or non-food items (dental abrasion). Dental attrition includes two prime components: occlusal attrition, resulting from the contact between the biting surfaces of upper and lower teeth, and interproximal attrition, a consequence of the slight movement between adjacent teeth in the same jaw [22,53]. Variations in the consistency of food, the food preparation methods, and grit contained in food produce dental abrasion patterns consistent with the well-documented patterns of attrition that reflect the biomechanics of mastication. Five degrees of dental abrasion established by Périer are used to highlight the disappearance of enamel and dentin [9]. The fifth degree is represented by pronounced abrasion, leading to the disappearance of the crown, which makes visible the pulp chamber. This is how radicular remains result.

Dental abrasion was identified in three male subjects, aged between 40 and 50 years (Fig. 8/a, b; Figs. 10, 11) and one female of 40–45 years (Fig. 9/a, b), affecting the mandibular and maxillary teeth. Radicular remains were identified in one female subject (40–45 years), affecting the lower left first premolar – P_1 (Fig. 9/c).

Edentia refers to the partial or total absence of teeth in the oral cavity, resulting in their falling after eruption, caused by several factors. The main cause of edentia is represented by dental caries and its complications. There are also other disorders, such as infections of the soft tissues or bone tissues (osteomyelitis), tumors or facial traumas which can cause edentia [23]. Edentia can be: frontal (missing incisors and canines, with interlaced spaces), lateral (missing premolars and molars, where the spaces can be unilateral or bilateral), terminal (uniterminal or biterminal), mixed (interlaced and terminal spaces), subtotal (with 1–2 remaining teeth), or complete, including both the upper and lower jaw [46]. A secondary effect of edentia is remodelling of the affected portion of the facial skeleton, by bone mass reduction through resorption and atrophy; this causes fall of the lower side of the face, due to the upper jaw and mandible decrease in height and reduction of mandibular thickness [13].

A subtotal edentia was identified in one male subject, aged between 35–40 years (Fig. 12).

DENTAL ENAMEL HYPOPLASIA

Dental enamel hypoplasia is a defect in enamel development, occurring when an individual is affected by illness or malnutrition of sufficient severity to interrupt the growth during childhood. It results from a temporary disruption of the growth rhythm of the ameloblasts, the cells forming the enamel, which results in the secretion of smaller amounts of tissue matrix in localised sections at tooth surface [2]. As a result, less enamel matrix is available for mineralisation at these sites, once the secretory phase is completed, resulting in a marked decrease in enamel thickness. Three types of enamel hypoplastic defects can be found – linear, pit and planar, which are believed to be formed by different mechanisms [20].

Dental enamel hypoplasia is increasingly used by anthropologists, because it indicates the general level of stress in a population. Many studies on children shown that hypoplasia may be caused by nutritional deficiencies or infectious diseases [18,31,54].

One or several hypoplasic signs may occur on the same tooth, their severity ranging from microdefects, visibile only microscopally, up to perfectly visible defects. In very severe cases, enamel aplasia may occur [45]. Usually, the hypoplasic defects appear bilaterally (left and right), both on the lingual and labial/ facial surfaces of the crown, preponderantly on the last one [21]. Their localization is more frequent in the median third of the crown, followed by the cervical and incisal/ occlusal thirds [17]. The sizes (depth and width) of the hypoplasic defects are directly correlated with the severity, duration and intensity of the stressing agent [44]. Enamel hypoplasia affects only the teeth whose crowns are formed during stress periods, the defects appearing only in the enamel portion formed in the time interval in which the stress factor had been active [41]. Some anthropological studies have focused on the frequency of defects [11,16,40,43], others have attempted at evaluating the duration and severity of stress by classifying defects according to size [4,11,12].

Out of the 10 subjects whose teeth had been investigated, dental enamel hypoplasia was identified in four cases: one child of 11–12 years (Fig. 13/a, b), one female of 20–25 years (Fig. 14/a, b) and two males aged between 25 and 40 years (Fig. 15/a, b, c, d; Fig. 16/a, b, c, d, e). In each case, enamel hypoplasia affected only a few teeth (acquired dental displasia). Hypoplasic defects are of horizontal linear type, being usually localized on the labial surface, in the median third of the crown.

On almost all dental crowns affected with hypoplasia, a well-delimited defect and several diffuse lines can be observed, which suggests that, at young ages, the analysed subjects have suffered some physiological disorders. The extent of severity of hypoplasia is a moderate one. The age interval at which the acute physiological stress was manifested ranges, generally, between 1.5 and 3.5 years. In the child subject M 313, the hypoplasic lines had been formed between 2.5 and 3 years, in the female M 592 at 1.5 and 3 years, in the male M 672 at 2 and 3 years, and in the male M 691 at 3 and 3.5 years, respectively.

4. CONCLUSIONS

The 10 human skeletons analysed in this study were discovered in the necropolis of Cândeşti (Vrancea county, Romania), dating from Middle Bronze Age (Monteoru Culture, 1550–1300 BC); they belong to - one child (*infans II*), one adolescent (♀), two adults (♂) and six mature (five ♂ and one ♀). We note that the frequency of odontopathies reported for these 10 skeletons is moderate.

At dental level, the following pathologies and anomalies were identified: dental caries and dental calculus (three cases for each), dental abrasion (four cases), radicular remains, edentia (one case for each), and enamel hypoplasia (four cases).

Our study provides further evidence that dental caries in prehistoric times mainly affected mature adults, heing mainly associated with gingival recession and periodontal disease, attacking the surfaces of the root. We also need to consider that the absence of some oligoelements or certain amino acids essential in teeth development can decrease their resistance to cariogenic agents.

As tothe dental enamel hypoplasia, as nonspecific indicator of health or/ and nutritional status in human populations, a in our sample it can suggest a biological fragility in trying to adapt to environmental changes.

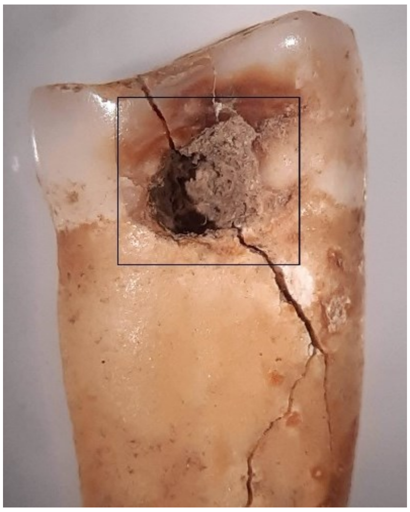

Fig. 2. Subject M 8, ♂, 35–40 year-old: interproximal caries, gr. II on upper left second premolar (P^2).

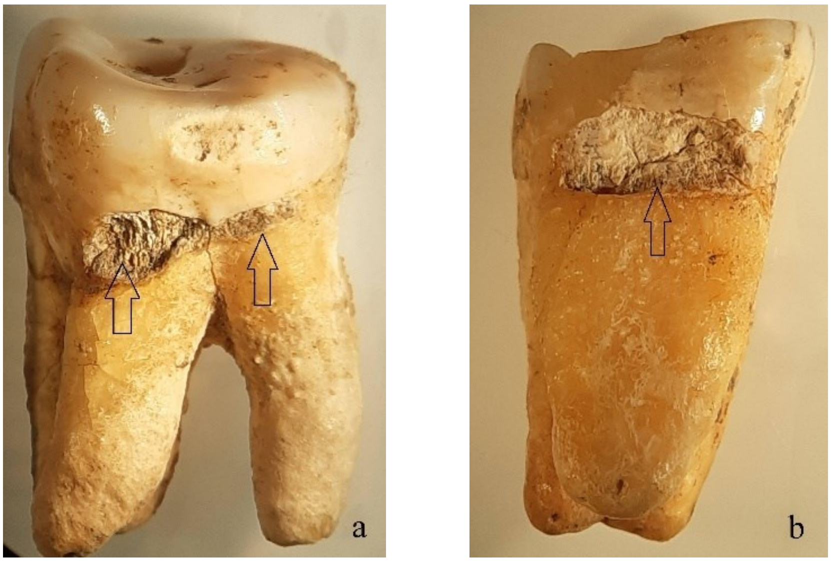

Fig. 3. Subject M 331- B, ♀, 40–45 year-old: a. cervical caries, gr. II on upper left second molar (M^2); b. cervical caries, gr. II→III on lower left second molar (M_2).

Fig. 4. Subject M 487, ♂, 45–50 year-old: a. upper jaw, root caries, gr. II, on the right second molar (M^2); b. root caries, gr. II on the superior right second molar (M^2) – lingual view; c. fragments of lower jaw; root caries, gr. II, on the right and left third molars (M_3); d. root caries, gr. II, on the inferior right third molar (M_3) – buccal view; e. cervical caries, gr. II, on the inferior left third molar (M_3) – buccal view.

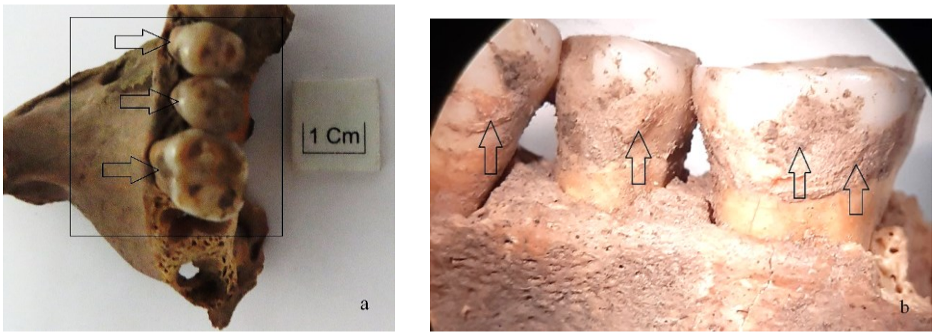

Fig. 5. Subject M138, ♂, 35 year-old: a. fragment of upper jaw with supragingival dental calculus, moderate amount (2), on the right P^1, P^2, M^1 teeth; b. detail of supragingival dental calculus, moderate amount (2), on the superior right P^1, P^2, M^1 teeth.

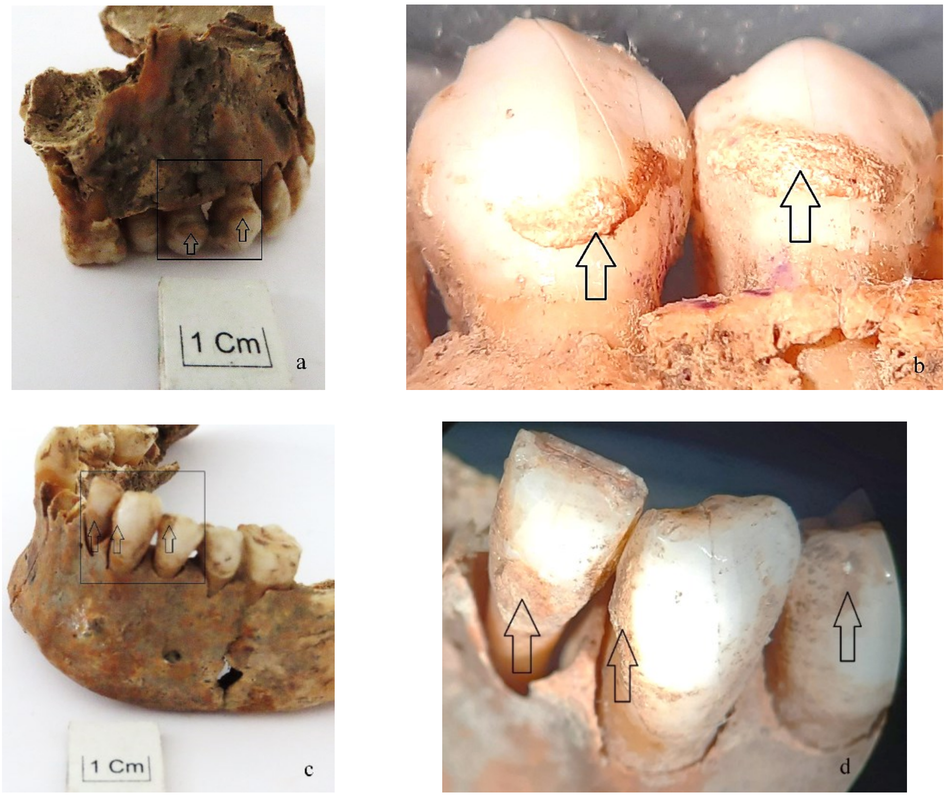

Fig. 6. Subject M683, ♀, 16–17 year-old: a. fragment of upper jaw with supragingival dental calculus, moderate amount (2), on the right canine (C), right first premolar (P^1); b. detail of supragingival dental calculus, moderate amount (2), on the superior right C and P1 teeth; c. lower jaw (incomplete) with supragingival dental calculus, small amount (1), on the left lateral incisor (I_2), canine (C), first premolar (P_1); d. detail of supragingival dental calculus, small amount (1), on the left I_2, C, and P_1 teeth.

Fig. 7. Subject M 8, ♂, 35–40 year-old: supragingival dental calculus on the upper left canine (C).

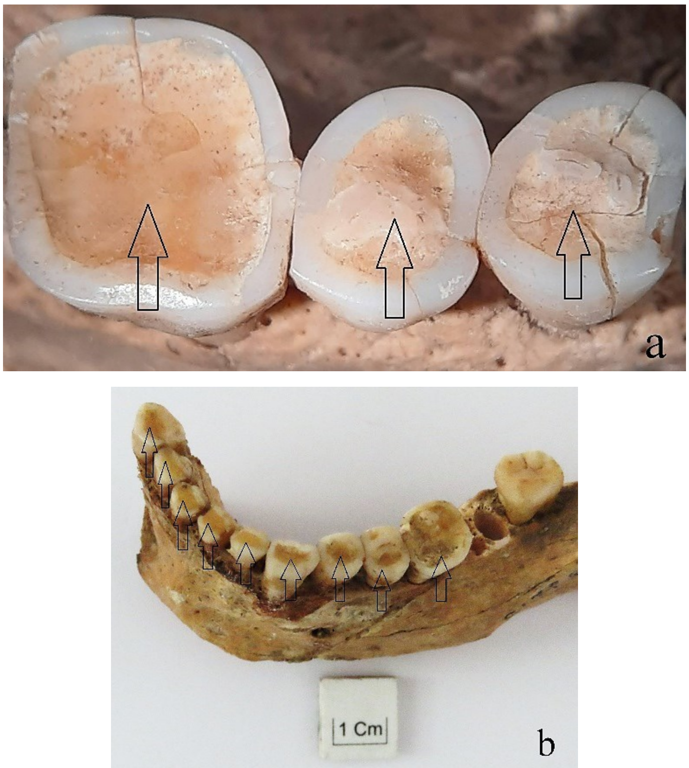

Fig. 8. Subject M 302, ♂, 40–45 year-old: a. occlusal view of left upper jaw with dental abrasion, gr. III, on the P^1, P^2, M^1 teeth; b. occlusal and interproximal view of the lower jaw with dental abrasion, gr. III, on the right I_1, I_2, C, P_1, P_2, M_1 teeth, and the left I_1, I_2, C teeth.

Fig. 9. Subject M 331- B, ♀, 40-45 year-old: a. dental abrasion, gr. IV, on the upper left M^1 molar; b. occlusal view of the lower jaw with dental abrasion, gr. IV, on the right P_2 premolar; c. extreme occlusal attrition creating exposure of the pulp cavity → radicular remain of the lower left P_1 premolar.

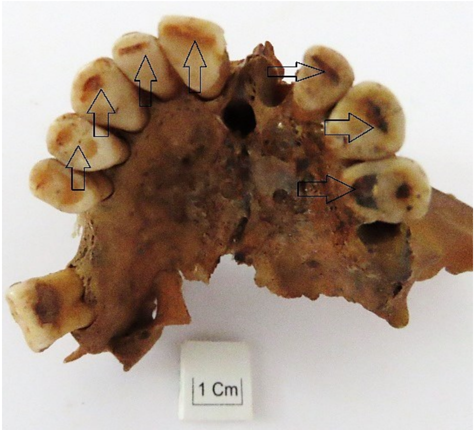

Fig. 10. Subject M 487, ♂, 45–50 year-old: occlusal view of upper jaw with dental abrasion, gr. III, on the right I^1, I^2, C, P^1, P^2, and the left I^2, C, P^1 teeth.

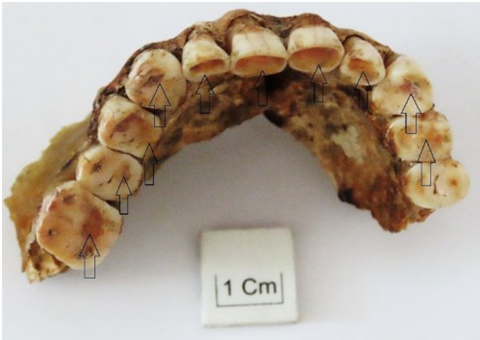

Fig. 11. Subject M 672, ♂, 35–40 year-old: occlusal view of upper jaw with dental abrasion, gr. II→III, on the right I^1, I^2, C, P^1, P^2, M1, and the left I^1, I^2, C, P^1, P^2 teeth.

Fig. 12. Subject M 8, ♂, 35–40 year-old: upper jaw with subtotal edentia.

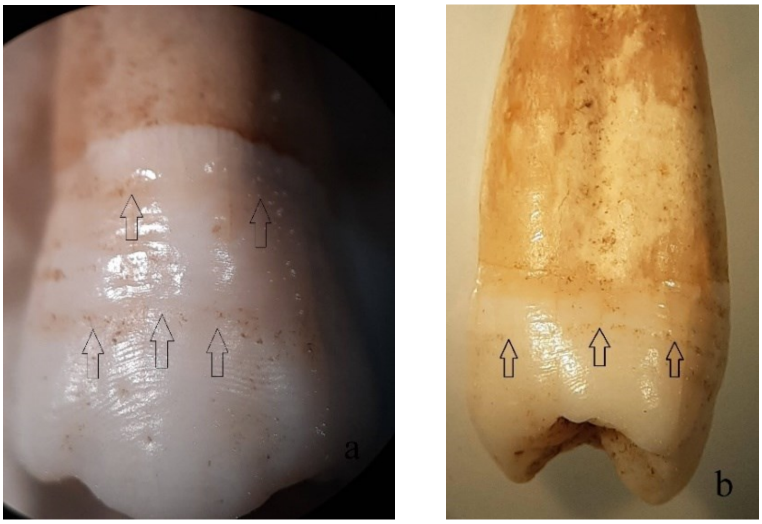

Fig. 13. Subject M 313, *infans II*, 11–12 year-old: linear enamel hypoplasia (LEH) on permanent right upper premolar P^1; a. anterior view; b. lateral view.

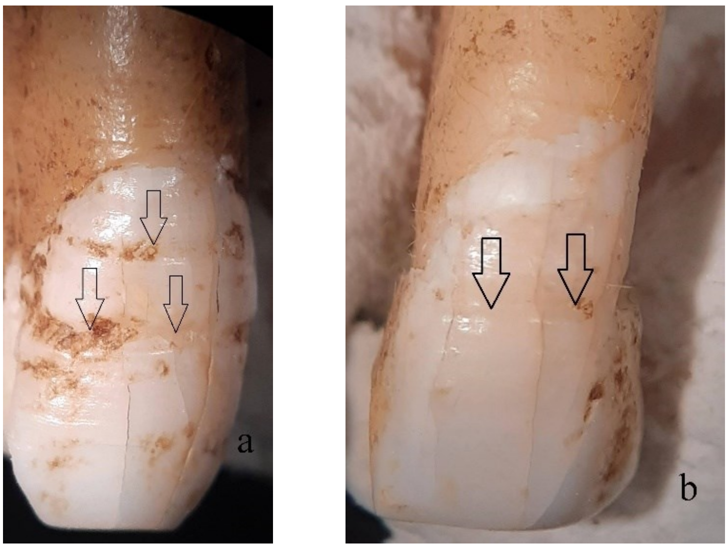

Fig. 14. Subject M 592, ♀, 20-25 year-old: linear enamel hypoplasia; a. upper right canine (C); b. upper right lateral incisor (I^2).

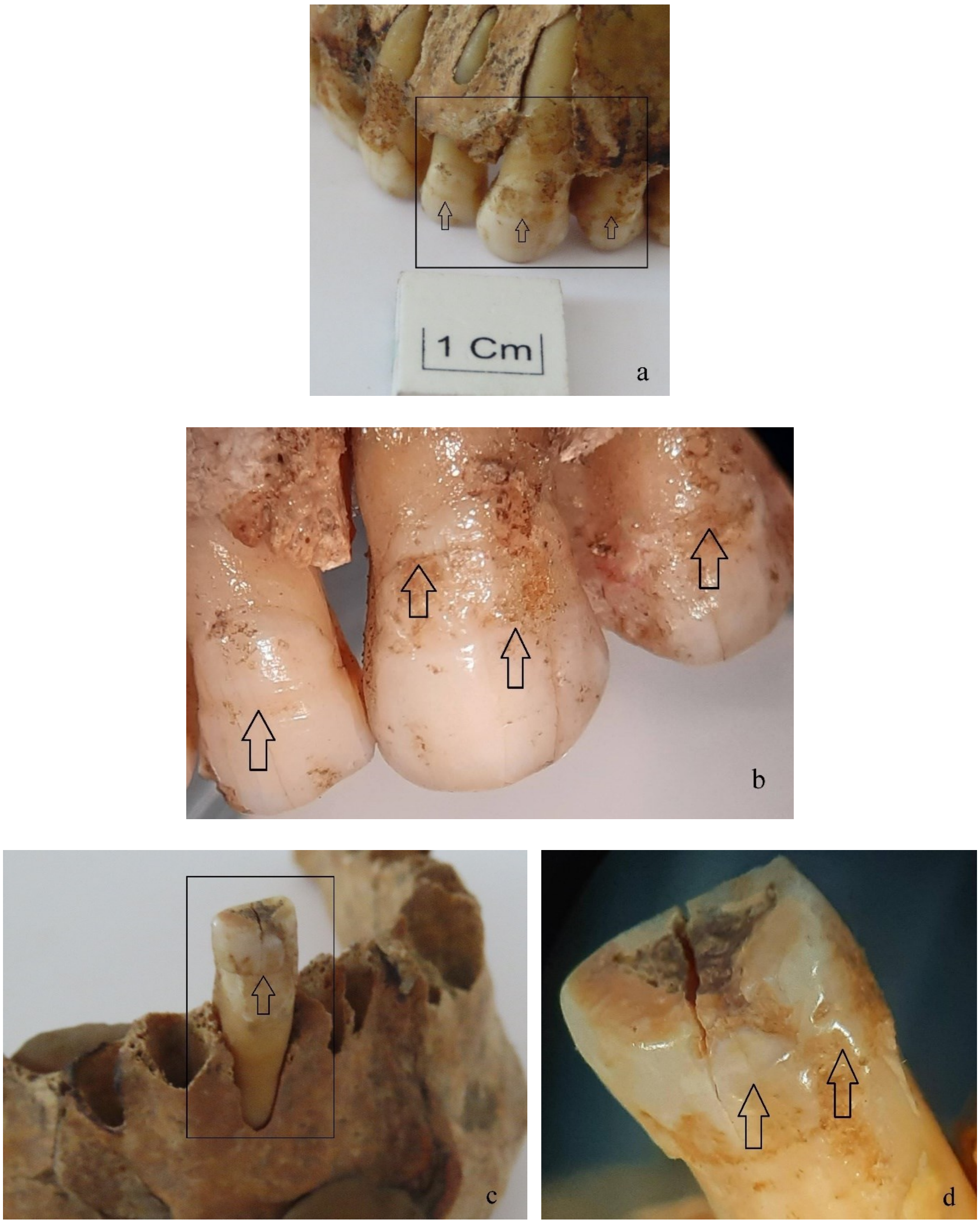

Fig. 15. Subject M 672, ♂, 35–40 year-old: a. fragment of upper jaw with linear enamel hypoplasia on the left I^2, C, P^1 teeth; b. detail of linear enamel hypoplasia on the left I^2, C, P^1; c. fragment of lower jaw with linear enamel hypoplasia on the right C tooth; d. detail of linear enamel hypoplasia and areas devoid of enamel on the right C.

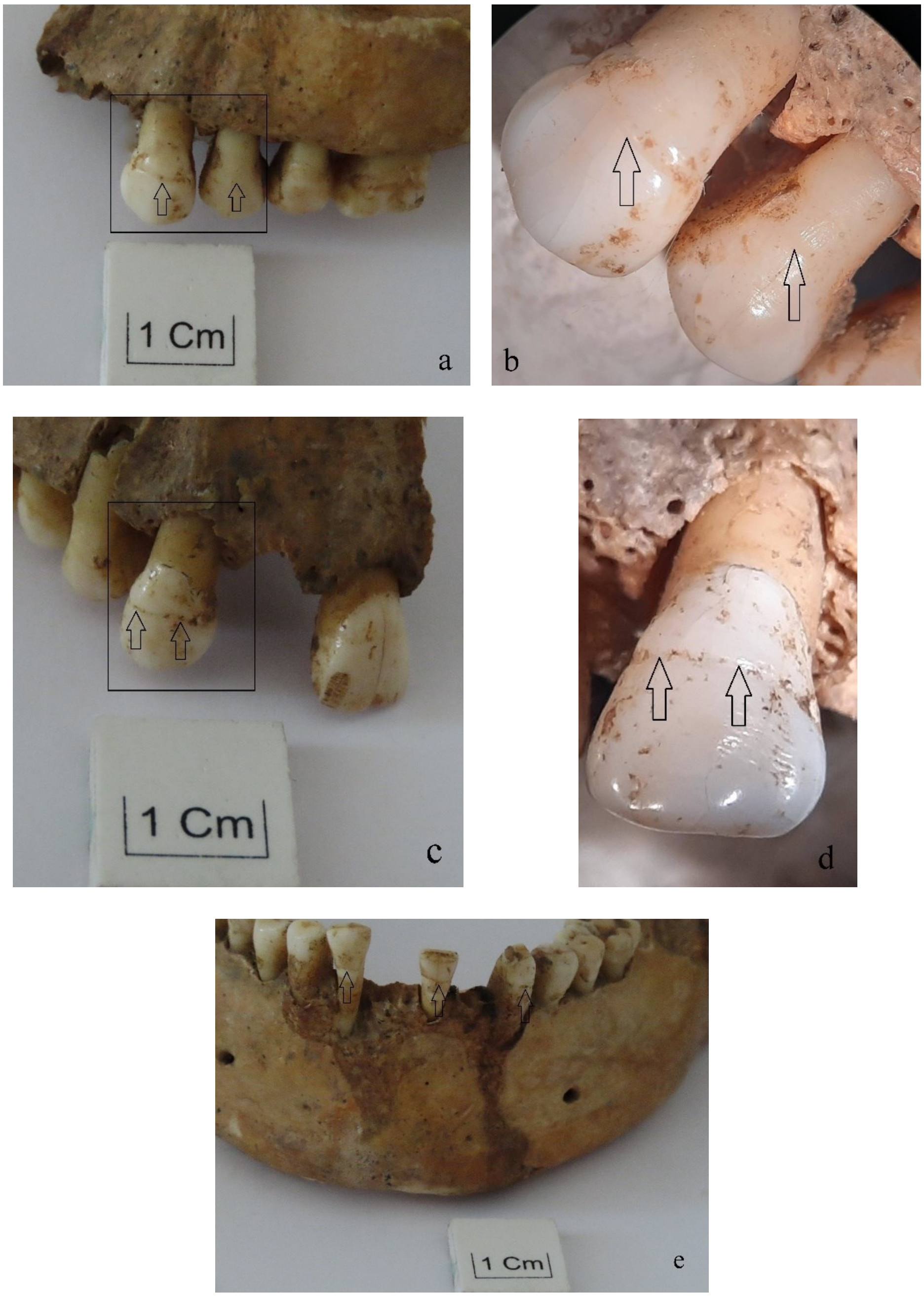

Fig. 16. Subject M 691, ♂, 25–30 year-old: a. left upper jaw with linear enamel hypoplasia on the C, P^1 teeth; b. detail of linear enamel hypoplasia on the left C, P^1; c. right upper jaw with linear enamel hypoplasia on the right C tooth; d. detail of linear enamel hypoplasia on the right C; e. fragment of lower jaw with linear enamel hypoplasia on the right and left C, right I_1 teeth.

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