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Non-metric dental traits in human skeletal remains from Transcaucasian populations: phylogenetic and diachronic evidence

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Abstract: The aim of the study is the assessment of biological distance between populations from Transcaucasia on the basis of the frequency of dental morphological traits. It is well known that these traits are characterised by a high inter-population differentiation, low sexual dimorphism, and their recording is loaded by relatively small intra and inter observer error. The dental morphological traits are successfully used in the description and explanation of the microevolutionary and ethnogenetic processes. This paper presents the results of the odontological differentiation of human populations from Transcaucasia. The comparative analysis was carried out on the basis of 12 groups. From the obtained results, we can draw the following conclusions: The populations of Armenian Highland and Georgia can be differentiated as far as the frequency of dental morphological traits are concerned. They also do not exhibit similar intragroup variability. Biocultural diversity of ancient Transcaucasian populations has not been studied extensively; therefore, delineating some of the patterns of phenotypic variation may be useful for understanding their ongoing evolution.

Key words: Armenian Highland, Georgia, odontology, non-metric traits

Dental anthropology is a study of morphological variation of teeth (Zubov 1973, 1979; Scott and Turner 1997). Dental traits have been a mainstay of physical anthropological studies for over a century (Swindler 2002). This variation manifests itself through several non-metric traits, which are small details in the shape of a tooth crown, in the shape or number of roots, and even in the number of teeth present (Scott and Turner 1997). Teeth, and particularly the phenotypic traits found in teeth, are the best source of information on biological relationships between populations or subgroups (Varela and Cocilovo 2000; Tyrrell 2000;

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Scott 2008; Khudaverdyan, 2013a). Their formation is independent of uterine influence, their evolution is slow and probably independent from natural selection; the development of anatomic traits of teeth is seemingly uncorrelated and presents low sexual dimorphism, and it also relies on a small and stable portion of the genome (Tyrrell 2000). The genetic factor in the presence of non-metric dental traits is theoretically associated with the presence of alleles and chromosomal loci (Scott and Turner 1997). Their quantity affects the expression of the trait, as well as its presence and frequency in a population or subgroup (Scott and Turner 1997). Odontological traits are used successfully in the description and explanation of both evolutionary and microevolutionary processes.

The term 'non-metric' implies structural variations of individual crown and root forms that are visually scored in two ways: "presence-absence" characters such as furrow patterns, accessory ridges, supernumerary cusps and roots, or, as differences in form such as curvature and angles (Hillson 1996; Zubov 1973, 1979; Scott and Tumer 1997). Numerous studies have demonstrated that morphological dental forms respond to microevolutionary forces of admixture (Turner 1969; Pinto-Cisternas et. al. 1995; Palikyan and Nalbandyan 2006), mutation (Morris et al. 1978), genetic drift (Turner 1969; Scott, Dahlberg 1982; Segeda 1993; Khudaverdyan 2009, 2013b; Vargiu et al. 2009), and selection (Dahlberg 1963), thus evincing their high degree of genetic control.

Investigations have provided information on local-scale non-metric variation in the following populations: European (Kaczmarek and Pyżuk 1985; Kaczmarek 1991, 1992; Segeda 1993; Cucina et al. 1999; Gravere 1999; Żądzinska et al. 1999; Lease 2003; Coppa et al. 2007; Vargiu et al. 2009; Zubova 2010), Central Asian (Khodjaiov 1977; Rikushina et al. 2003), The Near-Eastern (Smith 1978; Smith et al. 1987; Moskona et al. 1998; Sołtysiak and Bialon 2013), Asian and Pacific (Hanihara 1965, 1966, 1970; Hanihara and Minamidate 1965; Hanihara 1992; Sasaki and Kanasawa 1998; Kitagawa 2000), Indian (Lukacs and Walimbe 1984; Lukacs and Hemphill 1991), Siberian (Tur 2009; Zubova 2008), Australian (Townsend and Brown 1981; Townsend et al. 1986, 1990) and North American (Sciulli 1998; Tocheri 2002; Ullinger 2003; Lease 2003; Lease and Sciulli 2005; Edgar and Lease 2007). Surprisingly, past and present Transcaucasian populations have received little attention (Kashibadze 1990, 2006; Palikyan and Nalbandyan 2006; Khudaverdyan 2009, 2013b). The study of phenotypic diversity can help us understand the evolution and biocultural variation of the ancient and contemporary communities that today inhabit Transcaucasia and to obtain a more complete landscape of the dynamics that configure their gene pool.

Historical and archaeological sources enable a rough reconstruction of the population history in the Transcaucasian region. Changes in the population size may be estimated with the use of archaeological survey data and some migrations and/or ethnic changes were attested by written documents (Herodotus IV, Strabo 1964). However, the picture obtained from these sources is quite superficial, as the real impact of migrations on local population may only be loosely correlated with the change of language or self-identification, not even mentioning the material culture (Kramer 1977). For that reason, bioarchaeological methods of phenetic affinity reconstruction offer a reliable alternative, especially the research on dental non-metric traits, which are less subject to environmental stress and postmortem alterations than skeletal non-metric traits or metric measurements (Scott and Turner 1997). We have collected all non-metric dental traits that can be used for constructed phylogenetic trees of Transcaucasian populations with the aim of putting the root to the tree. A diachronic study or analysis concerns itself with the microevolution and change over time of dental traits. The results obtained will be presented in this paper.

Archaeological context

In early history, Caucasia was a crossroads linking the worlds of the East and West. From the 4th millennium BC to 1st millennium BC, tools and trinkets of copper, bronze and iron were commonly produced in this region and traded in neighbouring lands where those metals were less abundant (Pystovalov 2002, etc.). Wheeled vehicles and "kibetka-houses" on wheels invented in the Near East allowed cattlemen-farmers to move and survive with ease on the open steppes. Their movement across Eurasia in early times was not a military invasion, but a slow expansion caused by a decline in the child mortality rate and a resultant increase in population.

The craniological data allowed identification of alien Mediterranean characteristics influencing various ethnic Eurasian samples and revealed evidence of a migratory stream from the Caucasus and Near East (Dubova 2010; Khudaverdyan 2013a). The odontological and craniological data also exhibit close affinities between the Armenian Highland samples and the samples from Ukraine and Moldova (Cucuteni-Trypillianculture) (Khudaverdyan 2013b). Hence, it is possible to outline the cultural and ethnic communications in antiquity and the known role of the Armenian Highland (Kura-Araxes culture) as the intermediary between the ancient area of distribution of Tripolye cultures and the East countries (Lang 2005).

The Armenian highland and Georgia samples (Kura-Araxes culture) and the Catacomb culture samples from Kalmykia, Ukraine, Dnieper exhibit very close affinities to one another (Khudaverdyan 2013a). If we follow a hypothesis put forward and developed by Gamkrelidze and Ivanov (1984) considering the ancestral home of the Indo-European areas of the Armenian Highland and adjoining territories, whence other tribes reached the northern Black Sea coast both through the Caucasus and through Central Asia and the Volga region (carriers of a Catacomb culture ceremony), it is necessary to assign that movement to Aryan tribes which were among the first to reach Black Sea coast steppes through the Caucasus (or possibly by sea?). Khlopin (1983) connects the Catacomb culture with the Indo-Aryans, because catacomb burial ritual had roots in south western Turkmenistan from the early 4th millennium BC (Sumbar cemetery). Fisenko (1966) suggests that the Catacomb people were Proto-Hittites. Anthony (2007) supposed Catacomb people to be ancestors of Greeks, while Klejn (1984) determined that the Indo-Aryans originated from the Catacomb culture. The initial starting area (or one of the intermediate areas), as indicated by the anthropological data, would seem to be the Armenian Highland, and the Caucasus as a whole.

In the Classical time (1st century BC – 3rd century AD), the Caucasus saw the interaction of different ethno-cultural units, Iranian-speaking nomadic (Scythians, Sarmatians, Sauromatians, Saka) (Piotrovskii 1959) and local. The advancement of the Scythians, Sarmatians and Saka in the territory of Transcaucasia was accompanied not only by an interaction of various cultural elements, but also by a mixture. The detailed analysis of the anthropological materials from the Armenian Highland allows to explain not only the complicated anthropological compound of populations but also to discover the reason of anthropological and ethnic non-homogeneity in populations of the Ancient Age. Intragroup analysis revealed two groups within the population (Khudaverdyan 2012b). The dolichocephaly type in both cases is presented. The male skulls of the first group have been diagnosed as classical European sample. The second is the same European type, but the horizontal profile of the face (group II) is a little weakened. The female skulls sample has the same analogical image as the males. It is necessary to state that carriers of this complex remind one of the Scythians from the territory of the Dnestr region, Steppes of the Black Sea Coast, Ukraine, the Sarmatians from the Volga region and the Saka from the territory of Turkmenistan (Khudaverdyan 2012b). The invasions of the various tribes led, in stages, to a mixture of outsiders among the native Armenians, and the dilution of their ranks on the plateau.

The aim of this study is to establish new non-metric dental data for the ancient Transcaucasian populations. This will further the understanding of dental development and also the genetic relationships between these populations. Analysing the ethnogenesis of Transcaucasian populations, we have to take into consideration not only the Southern-Europoids odontological characteristics, but those of the Europo-Mongoloid, too. The morphogenetical processes passed off in the Transcaucasia during the Classical/Late Antiquity period were determined by the historically autochthonous as well as immigrant populations. All of them have their parallelism in the non-metric cranial trait sphere. Similar type of studies are commonly used to determine specific research questions such as the diachronic changes in trait expressions in a particular region (Lukacs and Hemphill 1991; Cucina et al. 1999; Gravere 1999; Coppa et al. 2007).

Materials and Methods

In total, the intergroup analysis included 12 series (Table 1) from the territory of Transcaucasia (Kashibadze 1990, 2006; Khudaverdyan 2009, 2013b) (Fig. 1). We assess dental reduction trends in two regions during three (Armenian Highland) and four (Georgia) prehistoric transitions Bronze Age-to-Modern period.

The author examined 6 samples (more than 181 individuals in total) of Bronze, and Classical/Late Antiquity periods from the territory of the Armenian Highland (Table 2). The series were grouped according to periods and local groups. The Early Bronze period (4000–3000 BC) farmer and cattle-breeder Landjik represent the Kuro-Arexes population of the Armenian Highland. The Late Bronze period sample is represented by the other Armenian Highland site (Black Fortress). The combination of remains from these two sites is justified for three reasons. First, the small sample sizes for the sites (Landjik, Black Fortress) were inadequate (from 10–13 individuals) for subsequent biodistance analysis. Second, the Landjik and Black Fortress sites rep-

Table 1. Transcaucasian craniological samples

	Region Sample name	Absolute dates Chronological unit	Author
1	Armenian highland Landjik, Black Fortress	Bronze Age: c. 4000–2000 BC	Khudaverdyan 2009, 2013
2	Armenian highland Lchashen, Shirakavan, Keti, Karchakhpyur	Bronze Age-Classical period/Late Antiquity period: c. 3000-2000 BC c. 1 BC–AD 3	Kashibadze 1990
3	Armenian highland Lchashen	Bronze Age: c. 3000–2000 BC	Kashibadze 2006
4	Armenian highland Beniamin, Vardbakh, Black Fortress I, Karmrakar	Classical period/Late Antiquity period: c. 1 BC–AD 3	Khudaverdyan 2009
5	Armenian highland Bingel Dag	20 century	Kashibadze 2006
6	Georgia Digomi, Mckheti	Bronze Age: c. 3000–2000 BC	Kashibadze 2006
7	Georgia Chiaturia, Mckheti I, Mckheti	Classical period/Late Antiquity period: c. 1 BC–AD 3	Kashibadze 2006
8	Georgia Dzinvali, Samtavro, Mckheti I, Mckheti	Early Feudal period: c. 6–10 AD	Kashibadze 2006
9	Georgia Dzinvali, Adjaria, Shatili, Adigeya, Mckheti	Average Feudal period : c. 10–12 AD	Kashibadze 2006
10	Georgia Dzinvali, Rustavi, Sioni, Shatili	Late Feudal period: c. 12–19 AD	Kashibadze 2006
11	Georgia Total group	Feudal period: c. 6–19 AD	Kashibadze 2006
12	Georgia Dzinvali	20 century	Kashibadze 2006

resent a cemetery from the Shirak Plain. Indeed, the geographic distance between the sites is short. Finally, the analysis of all non-metric traits examined by this study revealed that no significant differences exist among remains from the two sites, so data from these sites were combined for subsequent statistical analyses (Khudaverdyan 2009, 2013b).

Remains from the Lchashen site were treated as an independent sample because a sufficient number of crania from burial in Sevan pool were available for the study (Kashibadze 2006). The Bronze Age sample is represented by remains from four Armenia sites (Lchashen, Shirakavan, Keti, Karchakhpyur). Two of the four Armenia sites, i.e., Shirakavan and Karchakhpyur, represent samples dated from the 1st century BC – 3rd century AD (i.e. Late Antiquity period) (Kashibadze 1990).

Fig. 1. Localization of groups from Transcaucasia

Table 2. Non-metric dental traits definitions and code matching for the ranked traits used in this study (Zubov scheme) and in the Arizona State University Dental System (ASU scheme) cited according to Haeussler and Turner (1992): 277–78

Trait (Grades)	Tooth	Trait definition used in this study (Zubov 1968)	Matching ASU Dental Anthropology System and Zubov system ASU=Zubov
Midline Diastema	UI1	space between the upper central incisors equal or larger than 2 mm; 0 – no diastema, space <2mm; 1 – diastema, space ≥2 mm	0=0; 1=1
Dental crowding	UI2	crowding of the upper lateral incisors; 0 – crowding is not observed; 1 – crowding is observed	0=0; 1=1
Shovelling	UI1	shoveling of the upper central incisors; observed when the marginal ridges of the incisors are prominent and enclose a deep fossa in the lingual surface of the tooth: 0 – none; 1 – poorly delineated rollers along edges; 2 – well differentiated ridges on both sides, somewhat projecting above the surface; 3 – clearly expressed high ridges on the lingual surface giving the characteristic shovel- shaped form	0=0; 1=1; 2=2; 3–6=3
Reduced, peg-formed tooth	UI2	Distal lobe of second incisors reduced enough to produce a peg-shaped form; 0 – no reduction, lateral incisor width approximately 70 to 80% that of central incisor; 1 – lateral incisor mesial-distal width approximately 50% that of central; 2 – conical incisor with a pointed apex; 3 – peg-form tooth, crown height considerably less than adjacent tooth	2=2+3
Reduced, peg-formed tooth	UI2	Please follow above sample	0=0; 1=1
Hypocone	UM2	degree of reduction of the hypoconus on the second upper molars; 4 Hypocone well developed, forming a distinct disto-lingual corner of the crown, 4– Hypocone diminished, not forming a corner, 3+ Hypocone very reduced, 3 Absence of hypocone	3.5,3=4–
Carabelli's cusp	UM1	the small additional cusp on the mesiolingual corner of the upper first molar presents in a variety of different forms; 0 Absence, 1 Slightly uneven surface due to one or two barely visible grooves, 2 Slight swelling limited from the mesial and occulusal sides by a curved weakly expressed groove, 3 Groove has character of a cusp, 4 Cusp clearly expressed, 5 Large free-standing cusp	0=0; 1=1; 2=2; 3–5=3
1 pa (eo) 3	UM1	type of structure of the first furrow of the paracone on the first upper molar	Trait not used in the ASU System
Four-cusped	LM1	Cusp number mandibular molars 4 4 is highest number of cusps	4=4
Six-cusped	LM1	6 6 is highest number of cusps	6=6
Four-cusped	LM2	4 4 is highest number of cusps	4=4
Deflecting wrinkle	LM1	The deflecting wrinkle is one of the particular formations of the median ridge of the metaconid. The ridge, when the deflecting wrinkle appears, shows a stronger development in either its length or breadth and curves distalward at the central part of the occlusal surface.	0–1=0

2med II	LM1	the variant 2med II position of the second furrow of the metaconid	Trait not used in the ASU System
Distal Trigonid Crest	LM1	This trait is characterized by a crest or ridge that courses buccolingually along the distal aspect of the primitive trigonid, represented by the protoconid and metaconid. It often appears as an extension of the distal accessory ridge of the protoconid although the distal accessory ridge of the metaconid may also be involved in forming the crest.	0–1=0

The Classical period/Late Antiquity period (1st century BC – 3rd century AD) samples examined by this study include remains from Beniamin, Vardbakh, Black Fortress I, Karmracar (Khudaverdyan, 2009). The small sample sizes for the sites (Vardbakh, Black Fortress I, Karmracar) were inadequate (from 12–23 individuals) for subsequent biodistance analysis. The Beniamin, Vardbakh, Black Fortress I and Karmracar sites represent a cemetery from Shirak Plain and the geographic distance between the sites is short. After the Armenian genocide of 1915, Bunak gathered a big collection (Museum of Anthropology, Moscow) of human skulls (i.e. the victims of the genocide). The modern population includes remains of these people (Bingel Dag: Armenians from Musha) (Kashibadze 2006) (Table 3).

Two Bronze period samples (Digomi, Mckheti) were analyzed in this investigation from Georgia. The combination of remains from these two sites is justified because of the small number of groups (Table 2). The Classical period/Late Antiquity period (1st century BC – 3rd century AD) samples from Georgia examined by this study include remains from Chiaturia, Mckheti I, Mckheti I (total group). Inadequate number of remains were available from this site and, therefore, they were analyzed as a single sample. Four Early Feudal period samples (Dzinvali, Samtavro, Mckheti I, Mckheti /total group/) were analyzed in this investigation from Georgia. Average Feudal period (10th–12th c. AD) samples examined by this study include remains from Dzinvali, Adjaria, Shatili, Adigeya and Mckheti. Late Feudal period (–13th–19th c. AD) samples examined by this study include remains from Dzinvali, Rustavi, Sioni and Shatili. The modern population include remains from Dzinvali (Kashibadze 2006) (Table 3).

The frequency of fourteen odontological traits (non-metrical dental traits) of permanent teeth was analyzed. All traits were recorded according to the methodology used in physical anthropology and described by Zubov (1968, 1973) and also by Turner (Turner et al. 1991) for an ASU (Arizona State University) project, in the framework of a research project performed in Asia and Europe (Khodjaiov 1977; Kaczmarek and Pyżuk 1985; Kaczmarek 1991, 1992; Segeda 1993; Gravere 1999; Zubova 2008, 2010; Tur 2009; Rikushina et al. 2003). For definitions of Zubov's trait rankings and their correspondences with the ASU see Table 2 and also Table 1 in Haeussler and Turner (1992).

The following odontological traits were used in the comparative analysis: 1) midline diastema UI1, 2) dental crowding UI2, 3) shovelling UI1, 4) reduced-peg UI2 (grades 2+3); 5) reduced-peg UI2 (grade 1); 6) hypocone UM2; 7) Carabelli's cusp UM1, 8) 1 pa (eo) 3 UM1, 9) four-cusped LM1; 10) six-cusped LM1;

Table 3. Frequency of non-metric traits in comparative populations

Sample	Midline Diastema UI1	Dental crowding UI2	Reduced peg-formed tooth UI2 (2+3)	Reduced peg-formed tooth UI2 (1)	Shovelling UI1	Hypocone UM2	Carabelli's cusp UM1	Four-cusped LM1	Six-cusped LM1	Four-cusped LM2	1 pa (3) UM1	Distal Trigonid Crest LM1	Deflecting wrinkle LM1	2 med II LM1
1	23.7	62.5	0	67.5	35.8	37.5	31.3	14.3	0	64.7	21.5	42.5	42.5	29.2
2	2.4	1.2	0	12.9	0	34.2	43.4	16.7	2.8	–	43.4	7.1	16.7	41.7
3	3.6	1.8	0	0	0	32.7	48.7	23.3	3.3	72.4	38.4	10	16.7	40.0
4	10.5	78.5	10.9	65.1	45.1	30.5	46.7	17.8	5.8	71.3	41.9	50.9	38.1	53.4
5	9.2	3.0	1.0	19.4	–	40.6	58.8	9.9	0.3	91.6	41.7	3.8	13.3	11.9
6	4.9	1.7	3.6	8.2	15.5	10.3	47.1	9.7	4.9	–	78.6	8.9	18.5	14.8
7	11.4	0.0	0	–	7.1	23.8	43.8	10.8	5.4	93.0	33.3	0	28.5	33.3
8	3.2	4.6	0	0	7.7	25.7	28.6	11.8	0	83.6	25.0	0	8.3	12.5
9	3.2	1.2	0.3	0	4.0	20.6	36.7	8.9	6.5	93.3	38.8	6.6	7.5	17.5
10	5.2	1.7	0	0	33.4	32.9	60.1	5.1	2.3	95.0	40.5	2.1	0	12.5
12*	–	–	–	–	–	33.3	100	66.7	0	100	–	–	–	–

*not included in the statistical analysis

11) four-cusped LM2; 12) deflecting wrinkle LM1; 13) 2med II LM1; 14) distal trigonid crest LM1 (Table 2).

The above-mentioned traits were selected by taking into account the following criteria:1) the traits should not reveal inter-correlations as for the frequency of occurrence; 2) they should reveal high inter-group variability; 3) their degree or variant of formation cannot change with an individual's age, 4) it should be easy to find comparative data for different populations. Data are subjected to the Correspondence (Stat Soft STATISTICA 6.0 was used for this analysis) and Cluster analysis (Kozintseva and Kozintseva's statistical package (Peter the Great Museum of Anthropology and Ethnography, St. Petersburg).

Correspondence analysis has several features that distinguish it from other techniques of data analysis. An important feature of a correspondence analysis is the multivariate treatment of the data through simultaneous consideration of multiple categorical variables. The multivariate nature of a correspondence analysis can reveal relationships that would not be detected in a series of pairwise comparisons of variables. Another important feature is the graphical display of row and column points in biplots, which can help in detecting structural relationships among the variable categories and objects (i.e., cases).

One of the most commonly used agglomerative clustering techniques is UPGMA, or the unweighted pair-group method, arithmetic average algorithm, which measures similarity as the average distance between all cases in one cluster to all cases in another. It was originally developed for constructing taxonomic phenograms, i.e. trees that reflect the phenotypic similarities between groups.

That is, the average distance between all cases in the resulting cluster is as small as possible and the distance between two clusters is taken as the average between all possible pairs of cases in the cluster. UPGMA employs a sequential clustering algorithm, in which local morphological relationships are identified in order of similarity, and the phylogenetic tree is build in a stepwise manner.

Results

The 14 traits, their frequencies, and the number of individuals observed for each trait for the Armenian Highland and Georgia samples are provided in Table 3. The differentiation which can be traced in the Transcaucasian populations is demonstrated in Figures 2 and 3. In the following, patterns of dental reduction in populations of the Transcaucasia will be described.

Midline Diastema UI1. A "diastema" is a dental term referring to a space or gap between two teeth, and its size depends on that of the alveolar process (Zubov 1973). It is most commonly applied to the space found between the two maxillary central incisor teeth (upper front teeth: I[1]–I[1]). The secular decrease in the frequency of this trait reflects one of the aspects of dental reduction. The frequency of diastema in the Bronze Age populations of the Armenian Highland ranges from 2.4% to 23.7 %. It is rather low in the Bronze Age population of the Georgia (Fig. 4.1).

In the Classical/Late Antiquity period, it drops to (10.5%), and in modern Armenians the occurrence remains low (9.2%). The tendency, therefore, is quite pronounced. The frequency of diastema in the Classical/Late Antiquity period and Feudal Age populations of the Georgia ranges from 3.2% to 11.4%.

Dental crowding UI2. Crowding (mainly that of incisors) is one of the anomalies in the position of teeth, being a phenotypic dental response to the reduction

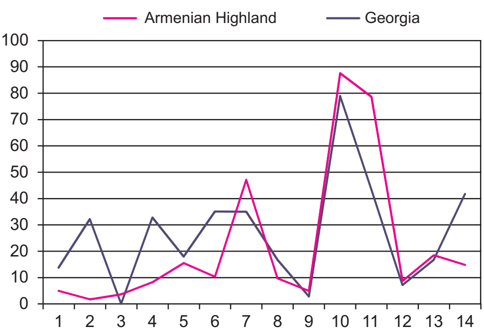

Fig. 2. Ranges of dental non-metric traits in samples from the Armenian Highland and Georgia in Bronze Age: 1 – Midline Diastema UI1, 2 - Dental crowding UI2, 3 – Reduced-peg UI2 (grades 2+3), 4 - Reduced-peg UI2 (grade 1), 5 – Shovelling UI1, 6 – Hypocone UM2, 7 – Carabelli's cusp UM1, 8 – Four-cusped LM1, 9 – Six-cusped LM1, 10 – Four-cusped LM2, 11 – 1 pa (3) UM1, 12 – Distal Trigonid Crest LM1, 13 – Deflecting wrinkle LM1, 14 – 2 med II LM1

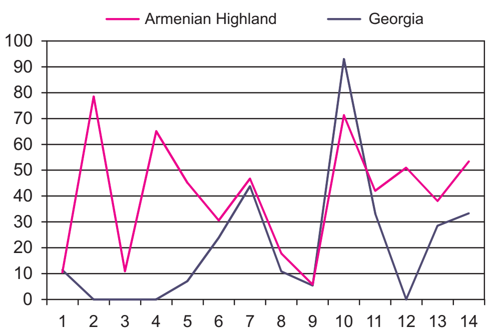

Fig. 3. Ranges of dental non-metric traits in samples from the Armenian Highland and Georgia in Ancient Age: 1 – Midline Diastema UI1, 2 – Dental crowding UI2, 3 – Reduced-peg UI2 (grades 2+3), 4 – Reduced-peg UI2 (grade 1), 5 – Shovelling UI1, 6 – Hypocone UM2, 7 – Carabelli's cusp UM1, 8 – Four-cusped LM1, 9 – Six-cusped LM1, 10 -– Four-cusped LM2, 11 – 1 pa (3) UM1, 12 – Distal Trigonid Crest LM1, 13 – Deflecting wrinkle LM1, 14 – 2 med II LM1

Fig. 4. Non-metric dental traits in samples from the Armenian Highland and Georgia
4.1. Midline Diastema UI1; 4.2. Dental crowding UI2; 4.3. Reduced-peg UI2 (grade 1); 4.4 Shovelling UI1; 4.5. Hypocone UM2; 4.6. Carabelli's cusp UM1; 4.7. Four-cusped LM1; 4.8. Six-cusped LM1; 4.9. Four-cusped LM2; 4.10. 1 pa (3) UM1; 4.11. Distal Trigonid Crest LM1; 4.12. Deflecting wrinkle LM1; 4.13. 2 med II LM1 in samples from the Armenian Highland and Georgia

of jaws. Dental crowding UI2 occurs when there is disharmony in the tooth-to-jaw size relationship or when the teeth are larger than the available space. Although crowding UI2 is morphologically opposed to the diastema UI1, the secular tendencies in these traits are not necessarily directed oppositely; in fact, they sometimes occur in parallel. The frequency of lateral maxillary incisors crowding in populations of the Armenian Highland ranges from 1.2% to 78.5%. It was high in the Classical/Late Antiquity period people of the Beniamin, Black Fortress I, Vardbakh, and Karmrakar (Armenian Highland). The drop of frequency to 3% in 20th century Armenians is rather unusual. Crowding UI2 of the teeth in the Early Feudal Age Georgia was higher than in Bronze Age. It is very rare in Georgia populations (Fig. 4.2).

Reduced-peg UI2. Lateral incisors are frequently smaller than medial ones. Maximal reduction of the lateral maxillary incisors, ultimately resulting in peg-shaped incisors, was rare in the Transcaucasian populations. A small increase of frequency of grades 2+3 is observed in the Classical/Late Antiquity period of the Armenian Highland (10.9%) and in the Bronze Age from Georgia (3.6%).

Grade 1 reduction UI2 (Fig. 4.3), however, was frequent during both the Bronze Age (Landjik, Black Fortress) and the Classical/Late Antiquity period (Beniamin, Vardbakh, Black Fortress I, Karmracar) in populations of the Armenian Highland. Its low frequency (19.4%) is observed in modern (20th century) Armenians. Whereas, the frequency of reduction UI2 (grade 1) in Bronze Age people of Georgia is 8.2%, not a single case has been registered in the series from burials of the Classical/Late Antiquity period and Feudal Age.

Shovelling UI1. Shovel trait is a combination of a concave lingual surface and elevated marginal ridges enclosing the central fossa in the upper central incisor teeth (average point 0–3). The mesial and distal lingual ridges of the incisors may be elevated producing a 'shovel-shaped' incisor. This trait is quite variable on the world scale and displays clear-cut geographical regularities. It is well known that the summarized percentage value of the shovel shaped forms (2+3) of the upper medial incisors varies between 0 and 15 in the Europoid populations (Zubov 1968), whereas the highest frequency of shovel-shaped incisors (75–100%) has been found in Mongoloid ones. The odontoscopical values characterizing the mixed groups from the zone of the Ural Mountains and Central Asia, i.e. East-Finns, Ugors, Kazakhs and Uzbeks have an intermediary position between the above mentioned extremes. Nevertheless, the frequency of shovel-shaped incisors is very high in the dental system of many people of India (Oraons, Munda, Santals) belonging to the Europoid area. According to Zubov (1973), evolutionary tendencies, too, are quite different: while in the Eastern groups the trait remained stable or tended to become more common, the frequencies of the shovelling gene in the West decreased quite markedly and in a regular fashion. At present, the frequency of the shovelling gene in the West appears to continue to drop, making the East-West differences even more pronounced (Zubov 1973). This process is counterbalanced by admixture. In the Bronze Age of the Armenian Highland the mean total shovelling frequency (forms 2+3) is 35.8%, and it increases in Classical/Late Antiquity period (45.1%). People of the Classical/Late Antiquity period exhibit the highest frequency, possibly evidencing admixture. It was high and in Late Feudal Age people of Georgia (33.4%) (Fig. 4.4).

The Classical/Late Antiquity period (1st century BC – 3rd century AD) saw the interaction of different ethno-cultural units in the Caucasus – Iranian-speaking nomadic (Piotrovskii 1959) and local. The advancement of the Scythians, Sarmatians and Saka in the territory of Transcaucasia was accompanied not only by an interaction of various cultural elements, but also by a mixture. The invasions of the various tribes all led, in stages, to a mixture of outsiders among the native Armenians and the dilution of their ranks on the plateau. It is generally accepted that in the 7th century BC the Scythians mounted their incursions into the Ancient Near East through the Caucasus. The Scythians first appear in Assyrian annals as Ishkuzai, who are reported as pouring in from the north some time around 700 BC, settling in Ascania and modern Azerbaijan as far as to the southeast of Lake Urmia. The artificial modification of skulls (such as bregmatic, ring deformations of the head was known in the ancient population of the Beniamin, Shirakavan and Karmrakar, Vardbakh) and teeth in Ancient on the Armenian Highland may be related to emerging social complexity and the need to differentiate among people, creating a niche for such a highly visual bodily markers (Khudaverdyan 2011).

Hypocone UM2. Hypocone (distolingual cusp) reduction of maxillary second permanent molar. Dahlberg's diagrams of degrees of cusp reduction were used for recording (Zubov 1973). The total occurrence of reduced forms 3+ and 3 of the upper second molars gradually increases from the Bronze Age to the 20th century. In the Armenian Highland, the distinctive feature of the Bronze Age populations is a relatively high frequency of hypocone UM2; later, the trait becomes less frequent in groups of the Classical/Late Antiquity period. The population of Shirakavan and Karchakhpyur (Armenia, Classical/Late Antiquity period) under study is also characterised by a very high of reduction of the hypokonus on M^2 45.8% (Palikyan and Nalbandyan 2006). Its highest frequency is observed in modern (20th century) Armenians (Fig. 4.5).

In people of Georgia, the variation range is considerable: Bronze Age 10.3%, Classical/Late Antiquity period 23.8 %, Early Feudal Age (–6th–10th c. AD) 25.7%, Middle Feudal Age (–10th–12th c.AD) 20.6%; Late Feudal Age (13th–19th c. AD) 32.9%, modern Georgians (20th century) 33.3%. The trait, therefore, is temporally unstable, and its variation is rather erratic in Georgia.

Carabelli's cusp UM1. Carabelli's trait is a morphological feature that can occur on the protocone of human maxillary molars. It is a quasicontinuous variable, i.e. it can be either present or absent, but when present, it exhibits continuous variation in expression. The expression of the trait varies from a slight or distinct single furrow, pit, double furrow, y-shaped furrow, or slight protuberance lacking a free apex, to a small, moderate or large cusp, which occasionally equals in size the main occlusal cusp. A pit and a furrow (single, double, y-shaped) are negative expressions of the trait, whereas a protuberance and a cusp are its positive expressions (Alvesalo et al. 1975). Carabelli trait is considered worldwide as a Caucasoid trait. Hanihara (1992) found low frequencies of this trait in Japanese and higher in black and white Americans, finding that this trait distinguishes Caucasoid populations of Asian and that in the latter predominate the groove and pit forms, whereas Turner (1984) found significant expressions in sinodontes, South American indigenous and north eastern Europeans. Rocha et al. (2007) in a population of Afro-Colombians in Colombia found significant frequencies of cusp expression, which is characteristic of populations of African origin and that, according to Zubov (1998), conforms to the southern Caucasoid dental or western equatorial complex. Certain researchers have noted that the frequency of this trait tends to increase over the last centuries (Brabant and Twiesselmann 1964).

A similar tendency is observed in Armenian Highland groups (Bronze Age: 31.3%–43.4%; Classical/Late Antiquity period: 46.7%, modern Armenians: 58.8%). In people of Georgia, the variation range is considerable: Bronze Age 47.1%, Classical/Late Antiquity period 43.8%, Early Feudal Age (c. VI – X AD) 28.6%, Middle Feudal Age (c. X – XII AD) 36.7%; Late Feudal Age 60.1%, modern Georgians 100% (Fig. 4.6).

Cusp number mandibular molars. The occurrence of reduced *four-cusped* LM1 in the Bronze Age population of the Armenian Highland ranges within 14.3%–23.3% (Fig. 4.7). People of the burial from Lchashen exhibit the highest frequency. In people of the Classical/Late Antiquity period of the Armenian Highland, the mean total four-cusp LM1 score is 17.8%. The frequency of four-cusp LM1 in populations of Georgia ranges from 5.1% to 66.7%. Its highest frequency is observed in modern Georgians (Dzinvali).

The frequency of the *six-cusped* LM1 is low in nearly all populations of the Transcaucasia. The trait is virtually absent in the Bronze Age population (Landjik, Black Fortress) of the Armenian Highland and Early Feudal Age of Georgia (Fig. 4.8). People of the Classical/Late Antiquity period of the Armenian Highland (5.8%) and Middle Feudal Age of Georgia (6.5%) exhibit relatively the highest frequency of the sixth cusp LM1.

In populations of the Armenian Highland, the frequency of the *four-cusped* LM2 tends to increase over time. People of Georgia display a high degree of the lower second molar reduction (Fig. 4.9).

1 pa (3) UM1 (type 3 of the first paracone (eocone) groove on the upper first molar). The frequency of 1 pa (3) UM1 in populations of the Bronze Age Armenian Highland ranges from 21.5% to 43.4%. The population of the Classical period/Late Antiquity period (41.94%) and the early 20th century Armenian series described in Bingel Dag (41.7%) reveal rather similar frequencies (Fig. 4.10). Population of the Bronze Age display a high degree of the 1 pa (3) UM1. Later, the trait becomes less frequent in groups of the Classical/Late Antiquity period (33.3%) and even rarer in Early Feudal Age (25.0%).

Distal Trigonid Crest LM1. This trait is likewise ancient and stable. Some specialists believe that it is highly diagnostic (Zubov 1973, 1979; Khaldeyeva 1992). Discrete dental traits are under genetic control (Scott and Turner 1997) and can be used to estimate genetic relationships among populations (Coppa et al. 2007; Irish 2006). The frequency of distal trigonid crest LM1 in populations of the Bronze Age Armenian Highland ranges from 7.1% to 42.5%. In the Classical/Late Antiquity period in the Armenian Highland, the frequency of the distal trigonid crest LM1 is 50.9, and it decreases in 20th century Armenians (Fig. 4.11). People of Georgia display a low degree of the distal trigonid crest LM1 (Bronze

Age 8.9%; Middle Feudal Age (c. X – XII AD) 6.6%; Late Feudal Age 2.1%).

Deflecting wrinkle LM1. The deflecting wrinkle is one of the particular formations of the median ridge of the metaconid. The ridge, when the deflecting wrinkle appears, shows a stronger development in either its length or breadth and curves distalward at the central part of the occlusal surface. This character was first described by Weidenreich (1937) in his papers on Sinanthropus and Gigantopithecus, and subsequently, von Koenigswald (1952) drew attention to the deflecting wrinkle appeared in the deciduous mandibular molars in modern Javanese. In addition, the frequency distribution of this character in Japanese per manent molars was reported by Suzuki and Sakai (1956) and those in Japanese per manent and deciduous molars by Hanihara (1970).

In the Bronze Age of the Armenians (Landjik, Black Fortress, 42.5%), the frequency of the deflecting wrinkle LM1 is higher than Classical/Late Antiquity period (38.1%). It was low in Bronze Age people of Georgia (18.5%), being maximal in the Classical/Late Antiquity period (28.5%) (Fig. 4.12). Interestingly, the frequency of deflecting wrinkle LM1 in Early Feudal Age (8.3%) and Middle Feudal Age (7.5%) is low.

2 med II LM1 is notation for an odontogluphic trait. 2 (II) indicates that furrow 2 (a second order furrow that occurs closer to the fovea centrale than furrow 1) goes into furrow II (a first order furrow that separates the protoconid from the metaconid) (Zubov 1973). The frequency of 2 med II LM1 in populations of the Bronze Age Armenian Highland ranges from 29.2% to 41.7%. In the Classical/Late Antiquity period of the Armenian Highland of the 2 med II LM1 frequency is 53.4%. The trait is low in the Bronze Age population of Georgia (14.8%). In the Classical/Late Antiquity period of Georgia the frequency of the 2 med II LM1 is 33.3%, and it decreases in Feudal Age (Early Feudal Age 12.5%, Middle Feudal Age 17.5 %; Late Feudal Age 12.5%).

Comparative analysis

Table 4 presents data concerning the frequency of the occurrence of 10 odontological traits in 11 populations of the Armenian Highland and Georgia. The frequency of trait in percents was converted into the frequency expressed in radians. A modified set of initial data was used in order to assess the degree of differentiation by means of a principal component analysis. This method converts original traits (in radians) into new traits (meta-traits) that are called principal components. The principal component analysis reduces the multidimensional set of variety to two or three-dimensional level losing only an inconsiderable percentage of information.

As is to be expected, the first dimension accounts for the majority (54.5%) of the intergroup discrimination. Taking into account the character of the connection between attributes in this component, it is possible to tell that the large values up to the first dimension axes correspond to groups with the four-cusped LM1 (0.979), the deflecting wrinkle LM1 (0.771), the 1 pa (3) UM1 (0.686), midline diastema UI1 (I^1–I^1) (0.597), the dental crowding UI2 (I^2) (0.541), and the 2 med II LM1 (0.501). The negative weight gives a four-cusped LM2 (–0.814).

The second dimension (28.6% of the total variability) are maximum for distal trigonid crest LM1 (0.689), the Car-

Table 4. The MCA singular values of seven non–metric dental traits in three dimensions for 11 samples*

Trait	Dimension 1	Dimension 2	Dimension 3
Midline Diastema UI1	0.597	–0.324	0.745
Dental crowding UI2	0.541	0.116	0.117
Hypocone UM2	0.494	–0.746	0.351
Carabelli's cusp UM1	–0.421	0.672	0.632
Four-cusped LM1	0.979	0.501	–0.492
Four-cusped LM2	–0.814	–0.134	0.541
Distal Trigonid Crest LM1	–0.158	0.689	0.221
Deflecting wrinkle LM1	0.771	0.352	0.426
1 pa (3) UM1	0.686	0.511	–0.269
2 med II LM1	0.501	0.203	–0.462
Percentages of inertia explained	54.561	28.671	20.352

*Samples are listed in Table 1 – Armenian Highland – 1 – Bronze Age, 2 – Bronze Age and Classical/Late Antiquity period, 3 – Lchashen, 4 – Classical/Late Antiquity period, 5 – Modern population; Georgia – 6 – Bronze Age, 7 – Classical/Late Antiquity period, 8 – Early Feudal period, 9 – Average Feudal period, 10 – Late Feudal period, 11 – Feudal period

abelli's cusp UM1 (0.672), the 1 pa (3) UM1 (0.511), and the four-cusped LM1 (0.501). The negative weight gives a the hypocone UM2 (–0.746). The third dimension accounts for the 11.4% of the intergroup. The weight gives a the midline diastema UI1 (I^1-I^1) (0.745), the Carabelli's cusp UM1 (0.632), and the four-cusped LM2 (0.541).

The graph of the first two dimensions in Figure 5 demonstrates how ethnic trends are visualized. The first dimension shows populations in the Bronze Age of the Armenian Highland (Landjik, Black Fortress; Lchashen; Bronze Age-Classical/Late Antiquity period: Lchashen, Shirakavan, Keti, Karchakhpyur) and the Classical/Late Antiquity period (Beniamin, Vardbakh, Black Fortress I, Karmracar). These are depicted on the positive-coordinate axis and are clearly separated from the other groups.

The Classical/Late Antiquity period sample from the Armenian Highland ((4) Beniamin-Vardbakh-Black Fortress I-Karmrakar) is clearly separated from the other Armenian groups. Analysis of the main odontological traits in these series indicates that their frequencies fit within the range characteristic for the European race and Mestizo (com-

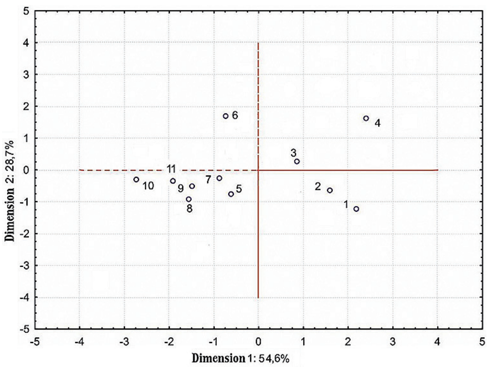

Fig. 5. Multiple Correspondence Analysis; 2D plot of column coordinates: dimension 1 × 2: 1 – Armenian Highland (Bronze Age), 2 – (Bronze Age and Classical/Late Antiquity period), 3 – Armenian Highland (Lchashen: Bronze Age), 4 – Armenian highland (Classical/Late Antiquity period), 5 – Armenian Highland (Modern population), 6 – Georgia (Bronze Age), 7 – Georgia (Classical/Late Antiquity period), 8 – Georgia (Early Feudal period), 9 – Georgia (Average Feudal period), 10 – Georgia (Late Feudal period), 11 – Georgia (Feudal period)

bined European and mongoloid descent). The biologically admixed group or morphological heterogeneity ((4) Armenian Highland: Beniamin-Vardbakh-Black Fortress I-Karmrakar) has a more complicated pattern of phenotypic relationships. As can be seen from the Table 3, a high value of dental morphological traits is revealed – double shovelling, distal ridge of trigonid and deflecting wrinkle of metaconid. The anthropological structure of the antique population of the Armenian Highland is non-uniform in the odontologic relation. The odontological material in big degree will be coordinated with craniological (Khudaverdyan 2012b) and non-metric cranial traits (Movsesyan and Kochar 2001; Khudaverdyan 2012a).

The Georgia group (Bronze Age: Digomi, Mckheti) are also depicted on the positive-coordinate axis. The Bronze period sample from Georgia (6) is also clearly separated from the other groups. We noted that the Digomi and Mckheti Georgian sample shows the closest affinity with the Timber Grave Ural culture (Khudaverdyan 2013b). Meanwhile, groups from Georgia (Classical/ Late Antiquity period: Chiaturia, Mckheti I, Mckheti; Feudal period: Dzinvali, Samtavro, Mckheti I, Mckheti; Dzinvali, Adjaria, Shatili, Adigeya, Mckheti; Dzinvali, Rustavi, Sioni, Shatili), and modern population of the Armenian Highland (Bingel Dag) cluster on the negative-coordinate axis. On the positive coordinates of the first axis, the more discriminate dental traits are the four-cusp LM1, the deflecting wrinkle LM1, and the type 3 of the 1 pa (eo) UM1. The first two traits show higher frequencies in the Lchashen, Landjik, Black Fortress and Beniamin, Vardbakh, Black Fortress I, Karmracar (Armenian Highland), and slightly lower frequencies in the groups from Georgia. On the negative coordinates, on the other hand, the most significant trait is the four-cusp lower second molars, which shows higher frequencies in the groups from Georgia.

In order to better visualize the pairwise distance, I used a cluster analysis. The dendrogram based on an analysis

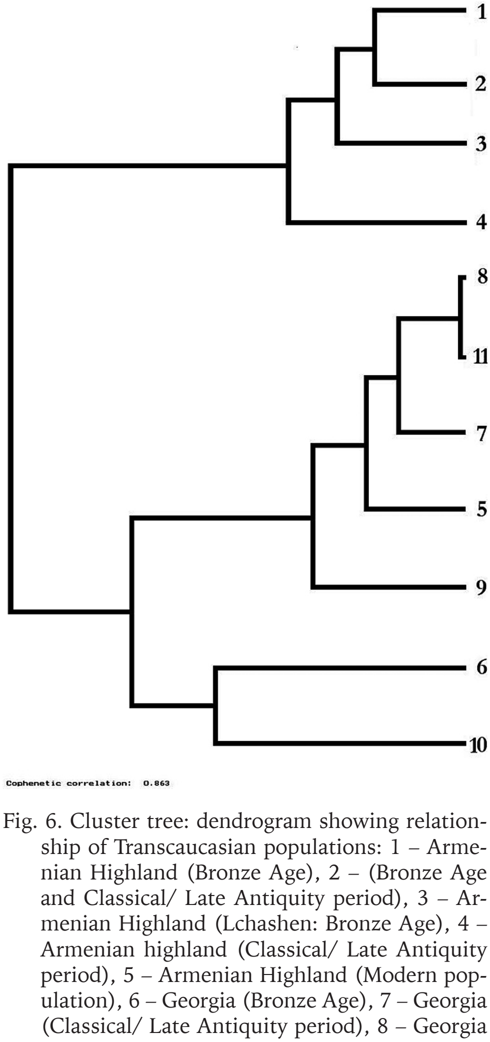

Fig. 6. Cluster tree: dendrogram showing relationship of Transcaucasian populations: 1 – Armenian Highland (Bronze Age), 2 – (Bronze Age and Classical/ Late Antiquity period), 3 – Armenian Highland (Lchashen: Bronze Age), 4 – Armenian highland (Classical/ Late Antiquity period), 5 – Armenian Highland (Modern population), 6 – Georgia (Bronze Age), 7 – Georgia (Classical/ Late Antiquity period), 8 – Georgia (Early Feudal period), 9 – Georgia (Average Feudal period), 10 – Georgia (Late Feudal period), 11 – Georgia (Feudal period)

of 10 traits among 11 groups is shown in Figure 6. Cluster analysis is the most commonly used method for displaying biological distances based on non-metric data. Resulting clusters are presented in dendograms, with each branch representing a separate clustering event. Caution must be exercised in interpreting cluster analysis dendograms. Because the dendograms resemble family trees, researchers have had a tendency to interpret them as a 1 to 1 reconstruction of population history, with each branch in the dendogram representing actual biological fissioning events. In reality, any reconstruction of a population history is far more complex, resulting from the complex interplay of genetic isolation, migration, and genetic drift. Thus, the dendograms are useful tools for identifying population similarity, but are not direct reconstructions of a population history.

Two main clusters can be illustrated if the dendrogram, obtained by using hierarchic method from the first 3 axes, is considered. The first cluster is represented by samples in Bronze Age of the Armenian Highland, differentiated from the second cluster composed of all the other groups. Within the latter, two sub-groups can be shown. The first is formed by the Bingel Dag (20th century Armenian) and the Feudal and Classical/Late Antiquity period samples of Georgia. The Classical/Late Antiquity period sample can be chronologically set between the periods of the Early Feudal Age and Middle Feudal Age, but may have maintained archaic traits because of their geographical isolation. The 2th sup-group consists of the Digomi, Mckheti (Bronze Age) and the Late Feudal Age samples.

Discussion and Conclusion

Secular dental changes in the populations of the Transcaucasia

Diachronic tendencies in cranial and dental morphology have occurred ever since anatomically modern humans began to populate our planet. One of the major tendencies was the increase of body length. Cranially, one of the most important trends was brachycephalization. Apart from those tendencies, irregular fluctuations in body size occurred, whereas the overall proportions displayed greater stability. A secular increase in body length observed over most of the 20th century was not exceptional. Dental changes are related to somatic ones. Certain aspects of dentition are rather labile, as evidenced by various patterns of the gracilization process, which is probably continuing. While brachycephalization (or debrachycephalization), gracilization, dental reduction, and the increase of body length may occur in parallel. The causes of those processes are probably varied. Microevolutionary tendencies may be triggered by ontogenetic changes, specifically the acceleration or deceleration of growth caused by endocrine, neurohumoral, trophic, and other factors. With our taking into account the secular changes in the dentition, an adequate reconstruction of population history is hardly possible, especially when issues of continuity versus replacement are discussed. Secular changes in dentition over the last few centuries and millennia have been studied in various countries. A diachronic dental crown size reduction has been observed among the Middle, Late and Post-Pleistocene hominid palaeo-populations and modern human populations (Frayer 1978; Calcagno and Gibson 1988). Various researchers report that this trend varies by tooth type and tooth dimension (Frayer 1978).

It has long been suggested that these changes might be caused by the transition to soft food (Dutta 1983) and the ensuing reduction of functional load. Comparative studies of twins (Potter et al. 1976), of parent and offspring (Goose 1971) and full versus half siblings (Townsend and Brown 1978) substantiate the claim that more than half of the variability in tooth crown size could be attributed to genetic factors (Brabant and Twiesselmann 1964; Scott and Turner 1997). Other experts point to the importance of environmental or biochemical processes, etc. (Dahlberg 1963). Dahlberg (1963) observed considerable population-specific variability in tooth size and form, so he hypothesised that changes in human dentition are the result of a relaxation of certain environmental pressures. He, therefore, proposed that European populations have a smaller tooth mass than do populations in "less favoured environments". Small teeth may be the outcome of "selection by crowding", whereby reduced load on the masticatory apparatus causes the reduction of alveolar processes, resulting in too little space for teeth (Zubov and Khaldeeva 1989). Brace (1963) presented the Probable Mutation Effect theory (PME) that suggests that in the absence of natural selection, mutations will be the main force acting towards a reduction of structural size and complexity of teeth and other organs. Thus, developmental processes, controlled by complex genetic mechanisms, will be disrupted resulting in an incomplete or a simplified dental structure (such as the change in cusp pattern). The PME is based on the concept of drift and stochastic microevolutionary mechanisms that act in the absence of selection (Sciulli and Mahaney 1991). Another possible factor in dental gracilization may be the high occurrence of caries, which mostly affects large teeth with complex occlusal surfaces. These processes demonstrate the importance of cultural factors in dental evolution. Transition to agriculture may lead to a reduction of dental size, as demonstrated by Sciulli (1979), who compared the dentition of hunters and gatherers with that of agriculturalists. It has been demonstrated that the Neolithic Revolution may have caused an abrupt decrease in tooth size. According to Frayer (1977), the dimensions of the facial skeleton during the Upper Paleolithic and Mesolithic in Europe decreased more rapidly than did the size of teeth.

Dental reduction in the Near East over the last six thousand years has been quite pronounced (Smith 1978). As Smith has shown, the direction of the microevolutionary process was the same, and differences between the Near Eastern groups were mainly due to various rates of this process and to isolation. Dental reduction, therefore, can lead not only to the decrease of between-group variation, but also to its increase. The objective of this study was to compare prehistoric and recent populations of the Transcaucasia in order to trace secular changes in dental morphology. Information about the southern gracile dental types can be found in Zubov (1979). The southern gracile type has low percentages of Carabelli's cusp UM1, somewhat increased distal trigonid crest LM1, four-cusped LM1, Four-cusped LM2 and low variant 2 med II LM1 (Khaldeeva 1992). The southern gracile type is characteristic for peoples of the Transcaucasian (Kashibadze 1990, 2006; Khudaverdyan 2009), Daghestan (Gadjiev 1979) and Bulgaria (Minkov 1979).

From the analysis of non-metric dentan traits, a common biological background can be hypothesized among the populations that inhabited Transcaucasia. Figures 2 and 3 present the differentiation of the comparative populations of the Armenian Highland and Georgia (Bronze Age and Classical/Late Antiquity period). Teeth of the population of the Armenian Highland (Bronze Age) are characterised by low frequency of Carabelli's cusp UM1, low frequency of six-cusped LM1 and well as the 1 pa (3) UM1. The occurrence of high reduced-peg UI2 was not recorded (variants 2 and 3). The frequency of dental crowding UI2, midline diastema UI1, reduced-peg UI2 (grade 1), hypocone UM2, four-cusped LM1, distal trigonid crest LM1 and deflecting wrinkle LM1 was very high (Fig. 2). Teeth of the population from Georgia (Bronze Age) are characterised by high frequency of Carabelli's cusp UM1, six-cusped LM1, four-cusped LM2 and 1 pa (3) UM1. The frequency of the Distal Trigonid Crest LM1, shovelling UI1, reduced-peg UI2 (grade 1), hypocone UM2, four-cusped LM1 and deflecting wrinkle LM1 is moderately higher of the population of the Armenian Highland (Classical/Late Antiquity period) that the average value for Georgia populations (Fig. 3).

The Armenian Highland groups perfectly fit this pattern, showing a high degree of biological continuity between the two periods (Bronze Age – Classical/ Late Antiquity period). However, the odontological type of the Classical period of the Armenian Plateau (4) complex was formed on a mix of local and newcomer populations.The 20th century from Armenian Highland (Bingel Dag) sample can be chronologically set between the periods of the Feudal Age and Classical/Late Antiquity periods groups from Georgia. Clear affinities are visible between the samples of Georgia.

The comparative analysis reveals that the populations of Armenian Highland and Georgia differentiated as far as the frequency of odontological traits is concerned. Those from the Armenian Highland are characterised by a different frequency in reduction traits in comparison with the above-mentioned series from Georgia. Morphological traits of teeth (non-metric traits) differentiated markedly the comparative populations. Therefore, they are a good method for studying the biological differentiation of skeletal populations. Diachronic changes in non-metric morphological characters of teeth in Armenian Highland and Georgia populations were at different rates for different traits.

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Conflict of interest

The Author declares that there is no conflict of interests regarding the publication of this paper.

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