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CONTENTS

STUDIES

ANCIENT HISTORY

ARCHAEOLOGY

ARCHAEOLOGICAL MATERIAL

ARCHAEOLOGICAL TOPOGRAPHY

NUMISMATICS

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ARCHAEOLOGY

ABSOLUTE CHRONOLOGY OF THE EARLY BRONZE AGE IN CENTRAL EUROPE, MIDDLE BRONZE AGE IN EASTERN EUROPE, AND THE "2200 EVENT"

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Abstract: Currently, archaeology uses dating systems that are not comparable, based on historical chronology, dendrochronology, and two types of radiocarbon dates: AMS and LSC. However, the latter suggest, as a rule, earlier dates. Contrary to this, the intervals based on historical chronology and dendrochronology are quite comparable. The intervals obtained by means of Bayesian statistics of AMS dates are also very close. The problem is aggravated by the fact that the use of the standard typological method does not allow complexes to be synchronized accurately, since the duration of the existence of some type can be different in two areas. More accurate evidence can be taken from the first appearance of any cultural complex as a result of migration. Such migrations were usually forced by natural disasters. Correspondently, the latter can be used as a chronological benchmark, which makes it possible for the processes taking place in remote areas to be connected. Based on all this, a chronological system of the European EBA, eastern European MBA and of the so-called "2200 even" is suggested. The obtained interval becomes younger and shorter than those based on the radiocarbon chronology.
Keywords: *absolute chronology, European EBA, radiocarbon, historical chronology, migrations*

1. INTRODUCTION

To a great extent, cultural transformations of the Bronze Age were driven by migrations that covered vast spaces. These migrations provided the spread of Indo-European languages, but the study of these processes requires an accurate chronology of different complexes. There is a theory about the Near Eastern origin of the Indo-Europeans[1]. However, Near Eastern archaeology, in addition to radiocarbon chronology, also uses a historical method, and the archaeology of Europe and the Eurasian steppe is based only on radiocarbon analysis. Sometimes this leads to confusion when, for example, historical dates are used for Near Eastern chariots and radiocarbon dates for the ones from the steppe[2]; but these dates are not comparable. Therefore, the study of the problem must

[1] GAMKRELIDZE/IVANOV 1995; GRIGORIEV 2002; GRIGORIEV 2021.
[2] KUZ'MINA 2000, 14, 19; ANTHONY 2007, 402, 403; DREWS 2017, 42.

be carried out within the framework of a sole chronological system.

Currently, the basic method used is the radiocarbon analysis, but its results have large deviations, wide confidence intervals and give much older dates compared to the Near Eastern chronology. Therefore, only results of statistical processing of large series of dates are worth to be discussed. However, most of the radiocarbon dates for Northern Eurasia have been obtained by the old LSC method, and only some cultures are provided with modern AMS dates. The latter are closer to the historical chronology, but the difference is still significant, and only the application of their Bayesian modelling allows us to bring the intervals closer to the historical dates. For this reason, it is incorrect to compare these different dating systems. Most scholars also ignore one more problem. As a matter of fact, the radiocarbon analysis is a result of mathematical procedures. With a standard deviation of ±1σ, the probability of the interval is 68.2%, and with a deviation of ±2σ – 95.4%. For a detailed study of the processes, the first probability is unreliable, but it is usually used, as the second variant gives wide intervals, and we lose the possibility to make chronological comparisons of any complexes.

A comparison of the Chinese and East Mediterranean chronologies demonstrated their coincidence, as well as the coincidence with the 'Middle' chronology of the Near East and dendrochronology. This means that the historical chronologies are adequate, and the radiocarbon chronology will be correct if its results are close to historical ones[3]. Therefore, it is necessary to try to link the Eurasian archaeological complexes to the Near Eastern historical chronology and dendrochronology, based on their typological comparisons. However, our chrono-typological schemes, even those based on stratigraphy, are often illusory. The problem is that the existence of any type (and even culture) could have a different duration in different areas. Therefore, we again obtain very wide and unreliable confidence intervals. It is possible to improve the situation by studying the first appearance of a particular cultural complex after migration. The problem of the duration of its analogies in the initial area remains, but for the new area, its appearance may be regarded as a relatively exact chronological benchmark. In such a way, migrations can help in the formation of chronological benchmarks to which other dates can be attached. A particular migration will always provoke a series of doubts, but by constructing broad and complicated processes, we will be able to correlate and improve the whole system step by step. At first glance, it might be seen as replacing rigorous systems based on empirical knowledge with apriori ones based on the logic of reconstructed events. However, we have discussed above that our "rigorous" knowledge is not so strict and rigorous, and our task is to prove or check the logical constructs with strict evidence.

A promising way to do so is the study of migrations. Each migration is a forced action, stimulated by an impossibility of further living in the old place. Usually, its reason is seen in the worsening of climatic conditions in some area, degradation of soil, etc. However, climatic periods are long, and climate changes are gradual. Most of the paleoclimatic evidence in Northern Eurasia is based on soil investigations, and it is impossible to obtain their accurate dating. Besides, human communities are highly adaptive. Changes realized during 100–200 years (or even 20 years) could not force people to change their lives so radically and migrate to remote territories. More important were abrupt changes that are difficult to reveal by the study of soils and sediments. However, long unfavourable phases create conditions when some abrupt changes become significant, and make people move. Therefore, the correlation of evidence on the abrupt climate changes and cultural processes might give a possibility to specify the chronology of the events. The latter will help to reach a more accurate understanding of the processes which took place in Eurasia. One of the most famous climate change was the so cold "2200 event". It is believed that it was responsible for the appearance in Eastern Europe of the post-Catacomb complexes: Abashevo, Babino and Lola cultures[4]. Therefore, it can serve as a chronological benchmark for the Eastern European and Ural archaeology. But, to obtain this benchmark, it is necessary to understand the nature of the climatic and historical processes of that time within broader frameworks.

2."2200 EVENT" AND CLIMATE CHANGES IN THE SECOND HALF OF THE 3RD MILLENNIUM BC

2.1. General processes of climate changes and volcanoes

There is a consensus that the "2200 event" triggered the collapse of the Akkadian and Harappan civilizations, the Old Kingdom of Egypt, the Chinese and European Neolithic, and the rise of the European EBA[5] cultures, El Argar, Únětice, etc.[6] At that time, in many places on the Globe, it became colder and drier for several centuries, but the process had many regional features[7]. Their study and synchronization suffer from many problems: 1) the nature of the evidence differs, since it is based on studies of lake sediments, settlement layers, tree-rings, isotopes, pollen analyses, etc., 2) in many cases, samples from the same area give different results, 3) different methods are used to date specific phenomena: comparable historical chronology and dendrochronology, uranium–thorium method, single AMS dates and serial dates with the Bayesian modelling, C14 analyses of samples from sea and lake sediments with their probable reservoir effect, and samples from settlements, etc. Sometimes, even in one table, we can see a synchronization of signals of chemical analyses of sediments dated by the AMS method, and signals of tree-rings. In some instances, the reconstructed events are considered simultaneous and interconnected, which is far from obvious. Therefore, many points in this concept

[3] GRIGORIEV 2022.

[4] MIMOKHOD 2018

[5] Abbreviations used in the text: EBA – Early Bronze Age, MBA – Middle Bronze Age, LBA – Late Bronze Age, EB – Early Bronze Age in the Levant and Anatolia, EH – Early Helladic, MH – Middle Helladic, EC – Early Cycladic.

[6] RISCH *et alii* 2015, 10–18; WEISS 2015.

[7] STAUBWASSER/WEISS 2006, 380–383.

are subjective[8]. Difficulties in dating and the use of different methods result in many dates having very wide intervals between 2500 and 1500 cal. BC[9], and possible deviations are ± 100–200 years. From studies with high resolutions it results that the event started from ca. 2200 cal. BC and lasted about 300 years[10],but it does not follow from this that 2200 cal. BC is the initial date for all regions.

It was a long and complicated process, and its general features are more or less clear. In Greenland, over the past 4000 years, a weak but persistent negative solar influence on temperature has been observed, which amounted to 1.4% for the entire period. In the southern latitudes, the temperature is rising, and in the temperate latitudes, it is relatively constant[11]. Periodically, the climate changes, based on changes in solar radiation which is influenced by orbital forcing. In the period under discussion, this led to the shift to the south of the summer position of the Intertropical Convergence Zone (ITCZ) and the weakening of monsoons in Africa and Asia. There was also a shift of the Greenland glaciers to the North Atlantic, as well as some cooling of the world ocean and development of glaciers in the mountains, but no strong correlation with volcanic activities was reported[12]. However, there is some correlation between the volcanic activities and the reduction of temperature in Greenland, most visible during the Little Ice Age (14th–19th centuries AD)[13], although signs of eruptions causing short climate fluctuations for several years are known for other periods of the Holocene[14]. They appeared mostly at the alternation of large climate periods, transitions to glaciation and *vice versa*, which is explained by the increased stress on the Earth's crust[15]. In the case of orbital changes, this stress could also occur, although not so strongly. Thus, volcanism and climate changes are not strongly caused by each other, but could have a common cause.

Could volcanoes cause significant climate changes? Investigations of tree-rings show that small eruptions can produce temperature decreases in the mid-latitude on the order of 1°C for up to 2 years[16], which is not significant for human communities. In addition to this, they can increase processes in the North Atlantic by shifting ITCZ southward more intensively for a short period. The fact is that the trigger of the "2200 event" was a change in the subpolar Atlantic, whose temperature dropped 1–2°C[17]. This provoked changes in the subtropical upper-level flow over the eastern Mediterranean and Asia, resulting in the decrease of precipitations there. For Asia, the major negative factor was the weakening of monsoons[18]. Therefore, even the short climate changes provoked by volcanic activities could have significant local consequences, or, in case of major eruptions, global changes, but in no case catastrophic ones. Unfortunately, it is questionable to use signs of volcanic activities in the Greenland glaciers to refine the archaeological chronology, since their dating for the Holocene, especially for the period between 2000 and 1000 BC, may have an error of up to 1%. Dating of the Antarctic ice shield is better: with an accuracy 0.5% for the Holocene and 1% for the Pleistocene[19]. For archaeological chronology, such accuracy is insufficient, and this also causes the discrepancy with the climate changes reconstructed from tree-rings. This was probably behind the conclusion that there is no correlation between volcanic events and climate changes[20].

At last, the influence of volcanoes on climate depends on many factors (location, season, sulphur content, etc.). In addition to volcanic aerosols, the growth of three-rings is influenced by altitude and local climatic conditions and events, such as droughts, and the effect of the latter is stronger than the volcanic impact. Detailed investigations allow these factors to be distinguished, and for the last millennium it is possible to reveal 86% of the eruptions whose signs are found in the Greenland ice, but for the 2nd millennium cal. BC – 46%, and for the 3rd millennium cal. BC – 31%. That is why, in comparisons to climate evidence based on tree-rings in the USA, Finland and Yamal, the coincidence of signs of volcanic events found in Greenland with short major climate changes during the 3rd and 2nd millennia cal. BC is recorded only in 2906/2905, 2036, 1626 and 1524 BC[21]. But there is one pattern: for the period 26th–23rd centuries BC, signals identified in tree-rings are very rare, and then their number increases: 2173, 2157, 2148, 2131, 2036, 2035, 2028, 2027, 2023, 1996, 1962, 1921, 1909, 1908, 1907 BC[22]. Investigations of tree remains in the Great Basin, USA, revealed the disappearance of trees for the period 2140–1795 BC, which had been caused by the treeline decline. It coincides with the "2200 event"[23]. But the problem of comparison with the Greenland ice chronology remains, and ideally, it is better to use dendrochronology. To solve the problem, a method of chemical analyses of tree-rings was suggested, which was successfully applied to Anatolian trees, and chemical changes provoked by the Santorini eruption have been recorded for the period 1560–1557 BC[24].

Thus, the common picture of the global climate deterioration in that period is undeniable. Similar cooling cycles repeated in the Holocene every 1500±500 years, and

[8] BINI *et alii* 2019, 556–564.
[9] Paleoclimate studies traditionally use age notation in BP rather than BC as in archaeology. Sometimes this leads to confusion even within the same work. To avoid this, I use here traditional archaeological BC dates, subtracting 2000 (not 1950 as must do) years from the BP dates. It is some kind of simplification, but it is not so important for understanding the overall picture, taking into account the wide confidence intervals of radiocarbon dates. There is also difference between the radiocarbon dates (cal. BC) on the one hand, and historical dates and dendrochronology (BC) on the other. In addition, single AMS dates and those with the Bayesian modelling also differ. The latter are clarified in the text specially.
[10] STAUBWASSER/WEISS 2006, 380, 383.
[11] KOBASHI *et alii* 2013, 2299, 2304.
[12] WANNER *et alii* 2008.
[13] KOBASHI *et alii* 2013, 2306, 2309.
[14] ZIELINSKI *et alii* 1997, 26630.
[15] ZIELINSKI *et alii* 1997, 26625, 26629, 26637.
[16] SCUDERI 1990, 67.
[17] DE MENOCAL 2001, 670.
[18] STAUBWASSER/WEISS 2006, 372, 377.
[19] ALLEY *et alii* 1997, 26367; CLAUSEN *et alii* 1997, 26713; SIGL *et alii* 2016, 782.
[20] SADLER/GRATTAN 1999, 188–190.
[21] See also HELAMA *et alii* 2013, where the coincidences are also not quite accurate, but during the period under our investigation the signals are absent.
[22] SALZER/HUGHES 2006, 57, 59, 60, 62, 66.
[23] SALZER *et alii* 2014, 5, 8.
[24] PEARSON *et alii* 2005; PEARSON *et alii* 2020, 8413.

they were responsible for 40–60% of climate fluctuations[25]. However, any orbital processes are very long and smooth. They are not able to bring abrupt changes, and it is not quite correct to use the term "event" for their description. It is necessary to consider the processes in different areas separately, since different factors influenced the climate.

2.2. Mesopotamia, Levant, Egypt

The idea of the "2200 event" was coined after excavations at Tell Leilan and Abu Hgeira on the Habur Plain in Syria, where the late Akkadian layer IIb dated to ca. 2200 cal. BC (the last date of this layer is 2254–2220 cal. BC[26] (68.2% probability)) was covered with a 0.5 cm layer containing tephra particles indicating a volcanic eruption. After this event, the settlement was abandoned for a long time until 1900–1728 cal. BC.

The overlying layers have signs of strong aridity, intense winds and erosion. But the layer with tephra demonstrated the same climate conditions as before its falling. As a result, a conclusion was drawn that these arid conditions had led to the collapse of the Akkadian civilization. This was synchronized with the weakening of the Indian monsoon, when precipitation had decreased by 30% (for the Habur Plain, a decrease by 30–50% was supposed), with climate problems in the Aegean Sea, Egypt, and Palestine. Analysis of tephra showed its difference from the tephra of Santorini and similarity with tephra of the volcanoes in Anatolia and the Caucasus. Certainly, the eruption could only have had a short-term and local effect on the climate, but not on the aridity for 300 years[27].

An identical situation was recorded in a remote area. Mesopotamian dust is transported in the summer towards the Persian Gulf. In the marine sediments of the Gulf of Oman, above the layer with tephra inclusions, layers of the Mesopotamian dust are present, indicating strong arid conditions. Analysis of this tephra showed its identity with that found in Tell Leilan and Abu Hgeira. These events were connected, and the difference of dates (2170 ± 150 cal. BC for the end of the Akkadian civilization in the Habur Plain and 2025 ± 125 cal. BC for these sediments – in both cases rare AMS analyses) was explained by the effect of marine sediments. These dust layers had been accumulating for about 300 years during 2025–1625 cal. BC. The second and less strong episode, when sediments with Mesopotamian dust had accumulated, is dated ca. 3200 cal. BC[28]. This "2200 event" triggered movements of many tribes, the Amorites, Gutians, Hurrians, and the collapse of the Akkadian Kingdom ca. 2154 BC.

Traces of these events are found in the neighbouring areas of Palestine and western Syria, where precipitation decreased by 20–30% and the number of settlements reduced[29]. About 2200 cal. BC, the level of the Dead Sea fell, but the sediments of other lakes indicate the increasing arid conditions between 2500 and 2000 cal. BC. In fact, the general trend towards the aridity in the area was carried out in three consecutive steps, ca. 3300–3000 cal. BC, 2500–1950 cal. BC and 1200–850 cal. BC, but sometimes wetter phases took place. Therefore, this "2200 event" was extended and began much earlier, although only ca. 2200 cal. BC this resulted in the end of many civilizations of the region, first in Upper Mesopotamia, and later (ca. 2050 and 1900 BC) in the more humid areas of Lebanon and Taurus[30]. It is confirmed by archaeological studies: in the coastal part of Lebanon, traces of the 2200 cal. BC crisis are not recorded[31].

Probably, these processes led to the problems in Egypt, well described in the "Dialogue of Ipuwer and the Lord of All", the fall of the Old Kingdom, and the beginning of the First Intermediate Period, which in the historical chronology occurred ca. 2160 BC[32]. The chronology of this period is very complicated, but the use of the Bayesian model for AMS dates allowed its beginning to be placed in the interval 2263–2145 BC (95% probability). In any case, it corresponds to the Mesopotamian events, and had the same reasons[33]. However, we may not use the climate changes for the synchronization, since, as we will see later, this process was very long and different in various regions. It was obviously the same period, but we cannot match its dates accurately.

2.3. Anatolia

The droughts of this period are recorded in Eastern Anatolia[34] and the Caucasus. In more western regions of Anatolia, a decrease in oak pollen is noted, although this may be interpreted as a human impact[35]. In most areas, the evidence has different resolutions. However, studies of oxygen and carbon isotopes of stalagmites in the Kocain Cave, province of Antalya, show a sharp cooling phase between 2260 cal. BC and 2180 cal. BC, and in the Uzuntarla Cave in eastern Thrace between 2050 cal. BC and 1950 cal. BC (there are no earlier dates). In the Sofular Cave, province of Zonguldak (on the Black Sea coast), no known climate events have been identified, which is explained by the low climate variability of the area. Resolution in lakes is worse, but all known Rapid Climatic Changes (i. e. the 5.2 ka BP, 4.2 ka BP, and 3.1 ka BP events) have been identified in Tecer Lake

[25] DE MENOCAL 2001, 668.
[26] But in areas with volcanic activity the radiocarbon dates can be older up to 100–200 years (WIENER 2010, 371, 372). Therefore, it is impossible to exclude the effect of the overlaying layer with tephra.
[27] WEISS *et alii* 1993, 995, 999–1002; WEISS/BRADLEY 2001, 3, 4; WEISS 2015, 42, 43.
[28] CULLEN *et alii* 2000. This second episode was revealed also in the Soreq Cave in Palestine, Arabian Sea and Kilimanjaro, and it is believed that it had a global character and resulted in the end of the Uruk civilization (STAUBWASSER/WEISS 2006, 379). Even in the very humid region of the Lower Yangtze, periods of drought of ca. 3400 and 3200 cal. BC are recorded (WU *et alii* 2021, 14). In Eastern Europe, it coincides with the Late Eneolithic sites, in particular, the Zhivotilovka-Volchanskoe group in Ukraine.
[29] STAUBWASSER/WEISS 2006, 381.
[30] ROBERTS *et alii* 2011, 148–152.
[31] GENZ 2015, 97.
[32] KITCHEN 1991, 206.
[33] HÖFLMAYER 2015, 123.
[34] Studies of sediments in Hazar Lake in Eastern Anatolia did not reveal traces of the "2200 event". In the previous period, the climate was humid and warm, and sharp dry phases are recorded only ca. 1500 cal. BC, 800 cal. BC, and 200 AD (ÖN *et alii* 2018). But for the whole layer, which accumulated for about 18,000 years, there are only six AMS dates of the mollusk shells (with a possible reservoir effect), and the period under discussion is reflected by a single date with an interval of 2327–1717 cal. BC. Therefore, the resolution of these dates is low.
[35] STAUBWASSER/WEISS 2006, 383.

in Central Anatolia. In Çumra Lake, province of Konya, ca. 2200 cal. BC lack sediments, which may indicate a significant drought. In Karagöl Lake in Northeastern Anatolia, the water level was higher than it is now, due to higher temperatures and snowmelt in the mountains. In the area of Konya and to the west in the valley of upper Meander, the number of settlements sharply decreased. Everywhere the proportion of sheep and goats increased, and the proportion of cattle and role of agriculture decreased. On the Aegean coast, many settlements were abandoned, and simpler forms of social life can be reconstructed in subsequent layers. But it did not occur in the east, where city-states were being formed: large edifices were built on Kültepe, and trade started to rise intensively. Therefore, the connections of these processes with the climate changes are not absolutely clear[36].

Investigation of plankton in the Northeastern Aegean shows the cold phase between 2200 and 500 cal. BC[37]. It is assumed that a gap between layers of Troy III and IV was caused by a severe drought[38]. In the Troad, since the period of Troy I, a continuous reduction in oak and pine is reconstructed, which could be associated with a human factor, but since the layer Troy III people started to use alluvial fields, and since Troy IV coastal fields. This can be explained by significantly drier conditions in the period 2200–1900 cal. BC compared to the period 3200–3000 cal. BC. In Troy IV, we see a certain diversification in crop production, due to the use of salt-tolerant species. Studies of carbon and nitrogen isotopes in barley demonstrate the absence of drought stresses in the EBA, but they are noted for Troy IV[39].

The diversification of farmed species in the Troad and changes in herds and flocks in other areas show the adaptive possibilities to the climate changes. Their scale was not so great to have resulted in a collapse, but they influenced the cultural changes. Consequences of the eruption, whose traces are revealed in the Habur Plain (and its tephra has been found there and even in the Gulf of Oman), could be more significant in Eastern Anatolia, and it could upset the balance of the system.

2.4. Mediterranean

In the more western regions of the Mediterranean, the climate changes are not so noticeable. In the Asea valley, Peloponnese, they have not been revealed[40]. But data from the Alepotrypa Cave show the beginning of the dry period ca. 2250 cal. BC, which lasted for ca. 200 years. It coincides with the end of EH II and most part of EH III[41].

In Northern Italy, pollen analyses of lake sediments show climate fluctuations. However, they were insignificant, and for the second half of the 3rd millennium cal. BC and early 2nd millennium cal. BC the droughts have not been identified[42]. In the Southern Alps and central Italy, water level in some lakes decreased, but in the others it increased, which points to the ambiguity of the process[43]. In Southern Italy, Sicily, and Malta, pollen analyses show a transition from the relatively wet conditions to the drier ones ca. 2200–2100 cal. BC, and then some shift towards wetter conditions again. But there were no catastrophic changes, and it is impossible to exclude that the results of these analyses were caused by an anthropogenic factor, although on the Aeolian islands, a drier phase between 2100 cal. BC and 1950 cal. BC is reconstructed by the ∂13C analyses[44]. Investigations of sediments in the Tyrrhenian Sea, based on planktonic foraminifera, pollen, tephrostratigrahy and oxygen isotopes analysis, show some cooling between 2300 cal. BC and 2050 cal. BC, and deforestation since 2700 cal. BC, which reached its maximum ca. 2200 cal. BC. However, the latter could be caused by the anthropogenic factor too[45].

Pollen studies in Portugal demonstrate a gradual drift towards drier conditions during the second half of the 3rd millennium BC, but it was insignificant[46]. Visible changes have not also been recorded in Spain[47]. In the southwestern Mediterranean, the smooth reduction of sea surface temperature (based on studies of mollusc shells) took place between 2700 cal. BC and 1200 cal. BC (from above 19.0°C before 2200 cal. BC to 18.5°C around 2200 cal. BC, and further decreasing to 17.5°C around 1200 cal. BC), but abrupt changes ca. 2200 cal. BC have not been recorded. There was a warmer phase until ca. 2500 cal. BC, and a cooler one after 1500 cal. BC[48].

In sum, the generalization of data from Italy to Arabia shows an evident tendency towards a drier climate, but this process began ca. 2600 cal. BC. With rare exceptions, there is no evidence of abrupt changes about 2200 cal. BC[49].

2.5. Central and Northern Europe

The climate in the Northern Hemisphere is driven by the North Atlantic Oscillation. A comparison of the chemical elements of lake sediments in southwestern Greenland with tree-ring data in Northern Europe shows that the peaks of these elements correlate with the process of temperature decrease. However, in the published figure, this decrease was insignificant, within 1–3°C, and, judging from the tree rings, it began about 2200 BC, whereas the peaks of elements in the sediments are dated to ca. 2000–1900 cal. BC. But there are earlier peaks, from ca. 2400 cal. BC[50]. It is necessary to understand the difference between the dates of temperature decrease based on dendrochronology and the dates of sediments based on radiocarbon analyses. Therefore, the peaks of elements ca. 2400 cal. BC may be close to the dendrochronological date of the cold phase beginning.

In Britain and Ireland, visible climatic changes have not been found, although the earlier Hekla 4 tephra horizon

[36] MASSA/ŞAHOĞLU 2015, 65, 67, 70–72.
[37] TRIANTAPHYLLOU *et alii* 2007.
[38] WENINGER/EASTON 2014, 438–440, 444.
[39] RIEHL/MARINOVA 2016, 319, 322–332.
[40] UNKEL *et alii* 2014, 13, 15.
[41] WEIBERG *et alii* 2015, 7.
[42] LEONARDI *et alii* 2015, 296, 297.
[43] MAGNY *et alii* 2009, 581.
[44] PACCIARELLI *et alii* 2015, 265–267, 272.
[45] MARGARITELLI *et alii* 2016, 63, 64.
[46] VALERA 2015, 421, 422.
[47] LULL *et alii* 2015, 391.
[48] KÖLLING *et alii* 2015, 449, 452, 453.
[49] FINNÉ *et alii* 2011, 3153, 3169.
[50] OLSEN *et alii* 2012, 808, 811, fig. 3.

(2350–2260 cal. BC) has been identified at some sites in Northern Ireland[51]. The Hekla 4 tephra layers found in Scotland are dated by the radiocarbon method to 2271–2150 cal. BC or 2280–2240 cal. BC, which shows the increased volcanic activity in this period[52]. In South Scandinavia, Northern and Central Germany, there are no traces of ecological crisis, with a single exception: a decline in the settlement activities ca. 2100–1700 cal. BC in Denmark and ca. 2300–2100 cal. BC in Schleswig-Holstein[53]. More accurate dates are given by the dendrochronology of Northwestern Germany, where the pine forest phases in the marshes are associated with a drier climate, and in wet conditions the pine in the marshes dies. Pine-forest phases are dated to 2328–2215 BC, and the main dying-off phase is dated to 2215–2168 BC. Three years can be distinguished during this period: 2215, 2190 and 2168 BC, when the trees stopped growing. Especially severe was the growth depression in 2168 BC, which lasted five years[54]. In the Danube basin, data on the climate changes and crisis in the period of the "2200 event" are absent[55].

2.6. Steppe of Eastern Europe

Investigations of soil under mounds of Eastern Europe show that the climate in the Middle Bronze Age (the second half of the 3rd millennium cal. BC) was noticeably drier than in the previous Early Bronze Age and the following Late Bronze Age. Especially arid conditions began ca. 2200 cal. BC, when the "post-Catacomb" cultural block started its formation[56].

2.7. China

It is believed that ca. 2200 cal. BC in China, a sharp and very long trend towards a drier climate started. It was caused by the weakening of the monsoons, which resulted in the decline of the Neolithic cultures and the rise of the Xia Dynasty[57]. Investigations of peat bogs of Dajiuhu and Qianmutian in Central China allow two periods to be distinguished: 2900–1500 cal. BC with better precipitations and highly variable, and 1500–900 cal. BC when the precipitation level was low. Probably, a relatively abrupt transition to a drier climate took place ca. 1600 cal. BC, but before this (ca. 2200 cal. BC), a noticeable decrease in precipitation and the following increasing aridity are recorded. But the date is not too accurate, as the section is dated by only 10 AMS analyses, and there is a gap between the dates 5488–5429 cal. BC and 1827–1788 cal. BC. So, the revealed aridification reflects only the general trend of the Holocene[58].

In the Yangtze basin, the Shijiahe and Liangzhu cultures ceased to exist (fig. 1). After 2200 cal. BC, the conditions became drier, which is also reflected in the fact that for the period between 4700 and 2200 cal. BC eight floods are identified, and after 1500 cal. BC only two. But the tendency to a drier climate began already in the Shijiahe period, and it was typical of the whole sub-boreal period (2450–450 cal. BC). Besides, on the Jianghan Plain in the Middle Yangtze basin, severe floods are recorded not only in layers of the previous Qujialing culture (2900–2600 cal. BC) but also between the late Shijiahe culture and Xia Dynasty (2100–1800 cal. BC). In the lower reaches of Yangtze, layers of the Liangzhu culture (3000–2000 cal. BC) are covered by silty deposits associated not with the sea transgression but with power floods caused by mainland waters. A significant drought is identified for the interval 2400–2100 cal. BC[59].

Strictly speaking, the climate changes in China are dated to ca. 2400–1900 cal. BC. Data from some sites (sediments in the Qinghai Lake, stalagmites in Shanbao and Dongge Caves) allow us to admit that the process of a sharp increase in aridity started about or shortly after 2500 cal. BC[60]. A study of sediments in the Huguangyan Maar Lake shows a transition to a drier and cooler climate ca. 2200 cal. BC, and carbon isotope in the Hani peat demonstrate a moisture reduction ca. 2000 cal. BC[61].

Thus, it was a long process of changes. About 2200 cal. BC, the decrease in precipitation is recorded, caused by the weakening of the Asian monsoon, but the general trend towards aridity began earlier, and all this could have caused the degradation of the Neolithic cultures. However, there were many regional features, and it is impossible to conclude that the decline of the Neolithic cultures was rapid, and we can synchronize it accurately with these climate changes. This is also complicated by the fact that the data from China are of low resolution and rather limited[62].

More complicated is the question of possibilities to connect it with the historical chronology. The fact is that in the Yangtze basin, the Shijiahe culture (3100–2300 cal. BC) did not cease completely. On its basis, the post-Shijiahe complexes formed (2300–1800 cal. BC)[63]. There is no reason to believe that in the Yellow River basin, the Neolithic was replaced by the semi-legendary Xia Dynasty, which was preceded by the completely legendary period of the Five Emperors. As the beginning of the Shang Dynasty (ca. 1558 BC in historical chronology) can be associated with the layer IV at Erlitou in the north of Henan Province[64], the previous Erlitou I - III layers may be associated with the Xia Dynasty. And, the material of these phases has many similarities with the late Neolithic Longshan culture[65]. It is necessary to pay attention to the vibrant Taosi culture in Shanxi Province, with rich burials and beginnings of palatial architecture[66]. In my opinion, it is the most reasonable candidate for the association with the legend of the Five Emperors, and it fits well in the Chinese tradition. The last three emperors of this period were Yao, Shun and Yu. The forth emperor, Shun, handed over his power and throne to Yu, who was the founder of the Xia

51 FITZPATRICK 2015, 809–812, 825.
52 TIPPING *et alii* 2008, 257.
53 MÜLLER 2015, 651–665.
54 ECKSTEIN *et alii* 2010, 239–241.
55 BERTEMES/HEYD 2015, 573; FISCHL *et alii* 2015, 513, 516.
56 BORISOV *et alii* 2011.
57 MA *et alii* 2008, 28, 33, 34, 39, 40; WU *et alii* 2021, 129.
58 see MA *et alii*2008, 32, tab. 1, fig. 6; MA *et alii* 2009, 118–121, 125, 127, 130.
59 WU *et alii* 2021, 8–12, 16, 18.
60 WANG *et alii* 2005, 855; MA *et alii* 2008, 37.
61 WU *et alii* 2021, 129.
62 WU *et alii* 2021, 18.
63 GUO *et alii* 2018, 61.
64 GRIGORIEV 2022.
65 ZHAO 1985, 288.
66 LI 2018, 117–134.

Fig. 1. Cultures of Shijiahe and Lianzhu in the Yangtze basin, Erlitou and Taosi in the Yellow River basin, and the dam in the Jishi Gorge.

Dynasty[67]. These five emperors were associated with different elements, of which Shun with water, and he ruled for 46 years. The major activity of the Five Emperors, including Shun, was located in the western and central parts of Shanxi Province, although Shun was buried in Hunan. But the last of these emperors, the Xia founder Yu, had his capital in the northeast of Henan[68], in the area of the future Xia and Shang. Thus, the legend corresponds to the displacement of the brightest Chinese culture from the southwest of Shanxi (Taosi) to the north of Henan (Erlitou) (fig. 1).

An enormous and catastrophic flood occurred at the time of Yao, and for a long time it was impossible to cope with it. The next emperor, Shun brought Yu to solve the problem, who after his success became the successor and founder of the new dynasty. Accordingly, he founded the dynasty about 50 years after the beginning of the Great Flood. In Chinese historical tradition, the start of the Xia Dynasty can be dated to ca. 2070 BC[69]. Based on the paleoastronomic evidence, it could have happened in 1953 BC[70], but Chinese paleoastronomy is probably a fiction created in the Zhou period, although it is not too far from reality[71]. There are other opinions. According to the Bamboo Annals, the first year of Yu is 1989 BC, but the refined chronology (also with the use of astronomical data) allows it to be dated ca. 1914 BC[72].

Investigations in the Jishi Gorge (Yellow River valley, Qinghai Province) have revealed remains of a dam that appeared after a landslip and formed a water reservoir about 12–17 km^3 (fig. 1). Its burst resulted in the flooding of a huge territory. A series of AMS dates have placed this event in the interval 1976–1882 cal. BC (95% probability), and a simplified date has been accepted ca. 1920 cal. BC. It has been associated with the Great Flood of Yu, which has allowed to date the Xia beginning ca. 1900 cal. BC, and it is close to the chronology of Nivison[73]. But if we take into account the duration of Shun's reign, the dynasty began later.

[67] CHANG 1999, 70, 71.
[68] NIENHAUSER 1994, 10–13, 16, 18.
[69] LEE 2002, 18.
[70] PANKENIER 1981/1982, 24.
[71] GRIGORIEV 2023.
[72] NIVISON 1999, 12.
[73] WU *et alii* 2016, 580–582.

In the chronology based on many AMS dates, the phases Erlitou I and II correspond to the intervals 1880–1640 cal. BC (phase I) and 1740–1590 cal. BC (phase II)[74]. Probably, it is impossible to reach a full coincidence, but in any case, we have a system well balanced with historical chronology, within the first quarter of the 19th century BC.

Thus, the beginning of the Xia Dynasty and the preceding catastrophe were not connected with the "2200 event". All data suggest that the processes of climate change towards drier conditions started about the mid-3rd millennium cal. BC, they were smooth, but ca. 2200 cal. BC, there was a more rapid development of this process.

2.8. *Intermediate conclusions*

From the discussed evidence, a conclusion follows: there was no "2200 event". There was a general process of climate change in the Northern Hemisphere towards cooler and drier conditions, which lasted for hundreds of years. It was slow and smooth because it was influenced by orbital changes, and these changes began not ca. 2200 cal. BC, but about the middle of the 3rd millennium cal. BC. An exact date, in this case, is impossible.

In most regions, these changes were not so significant as to cause the dramatic cultural transformations that we see. The decreasing European temperature up to 1–3°C and a similar decrease in the sea surface temperature were insufficient for these changes in the cultural systems. For the temperate latitudes, these climate changes could not be crucial (although there was aridity in the steppe), and the European climate was milder, due to the influence of the Atlantic. Human communities were able to adapt to these small changes. Therefore, for Europe, we may exclude the impact of climate on the cultural transformations in this period. The situation was different in East Africa and Asia, because even these small temperature changes in the North Atlantic led to a gradual weakening of the monsoons. Judging by the case of China, these processes began before 2200 cal. BC, they were noticeable but not so sharp as to break the existence of traditional cultures, which were degrading slowly. Therefore, all these processes do not help us in solving our task, the dating of migrations. Undoubtedly, the general worsening of the situation reduced the adaptive capabilities of societies, and some abrupt changes for one or three years, provoked by some local reasons, could trigger migrations.

The only evidence of a catastrophe is the layer with volcanic ash above the late Akkadian settlements in northeastern Syria, which gives us a date within the second quarter of the 22nd century BC[75] ("Middle" chronology of Mesopotamia). This event could and did provoke migrations and instability in the Near East. It is not excluded that a small temperature decrease could intensify the general climatic process, but for a short period. It may be demonstrated by evidence of increased aridity in many regions. Therefore, it is possible that the eruption was strong enough. But verification of this supposition needs high-resolution data.

[74] ZHANG *et alii* 2008, 200.

[75] See above about the signals of abrupt climate stresses in 2173, 2168 and 2157 BC identified in tree-rings. But it is impossible to make a choice.

However, this date may be used as a benchmark for our further discussion. For the archaeology of the Yellow River basin, the relevant date of the Xia beginning is within the first quarter of the 19th century BC, and from this does not follow that it may be used as a boundary for other cultural transformations, especially in South China.

3. CULTURAL PROCESSES IN THE SECOND HALF OF THE 3RD– EARLY 2ND MILLENNIA BC

The discussion of climate changes shows that the only significant natural event that not only could but caused large-scale migrations during this period was the eruption of some volcano in Anatolia in the second quarter of the 22nd century BC, and it coincided with the progressing colder and drier climatic phase in the Northern Hemisphere which probably had begun as early as the 25th–24th centuries cal. BC. The further discussion of the European materials will allow us to see how these processes influenced cultural transformations, as well as to identify chronological benchmarks, making it possible to link the EBA cultures with the historical chronology. The main European contacts with the Near East were being carried out through Western Anatolia, from which we must start.

3.1. *Western Anatolia*

Significant changes occurred in Western Anatolia in the EB 2 (the early 3rd millennium cal. BC). Horseshoe-shaped bastions appeared in the layer Liman Tepe V, and during the entire Bronze Age they were probably the most powerful fortifications in the Aegean. The monumental citadel demonstrates that the city became an important administrative and religious center[76]. In the layer Liman Tepe V2 (ca. the mid-3rd millennium cal. BC), the wheel-made ceramics appeared, identical to that of the Kastri/Lefkandi I phase in the Aegean. Gradually, the proportion of this pottery increased, and the first *depas* vessels appeared, also with some delay, as in Greece. Similar processes took place in Miletus[77]. They have an exact correspondence in the Cyclades and in mainland Greece, where Greeks came from Anatolia in the EH IIb. And, judging from their sites distribution, this migration started in this area of the Anatolian coast[78] (fig. 2).

Changes of the next period began in the Troad: at the end of Troy III (ca. 2150 cal. BC), the settlement was abandoned, and it remained unsettled for about 100–200 years until the beginning of Troy IV[79]. The latter is synchronized with the beginning of EH III in Greece[80]. Although the culture of Troy IV continued the local Anatolian traditions, its buildings were ordinary, and there were no outstanding edifices, as in the previous period. This corresponds to the environmental problems in the Troad that we have discussed above.

[76] ERKANAL/ŞAHOĞLU 2016, 162, 164.

[77] KOUKA 2013, 572–574.

[78] GRIGORIEV 2022.

[79] WENINGER/EASTON 2014a, 157–175.

[80] PAVÚK 2007, fig. 1; BLUM/RIEHL 2015, fig. 5; BLUM 2016, fig. 9. See also a synchronization of EH III with Troy III–V (KOUKA 2013, fig. 1).

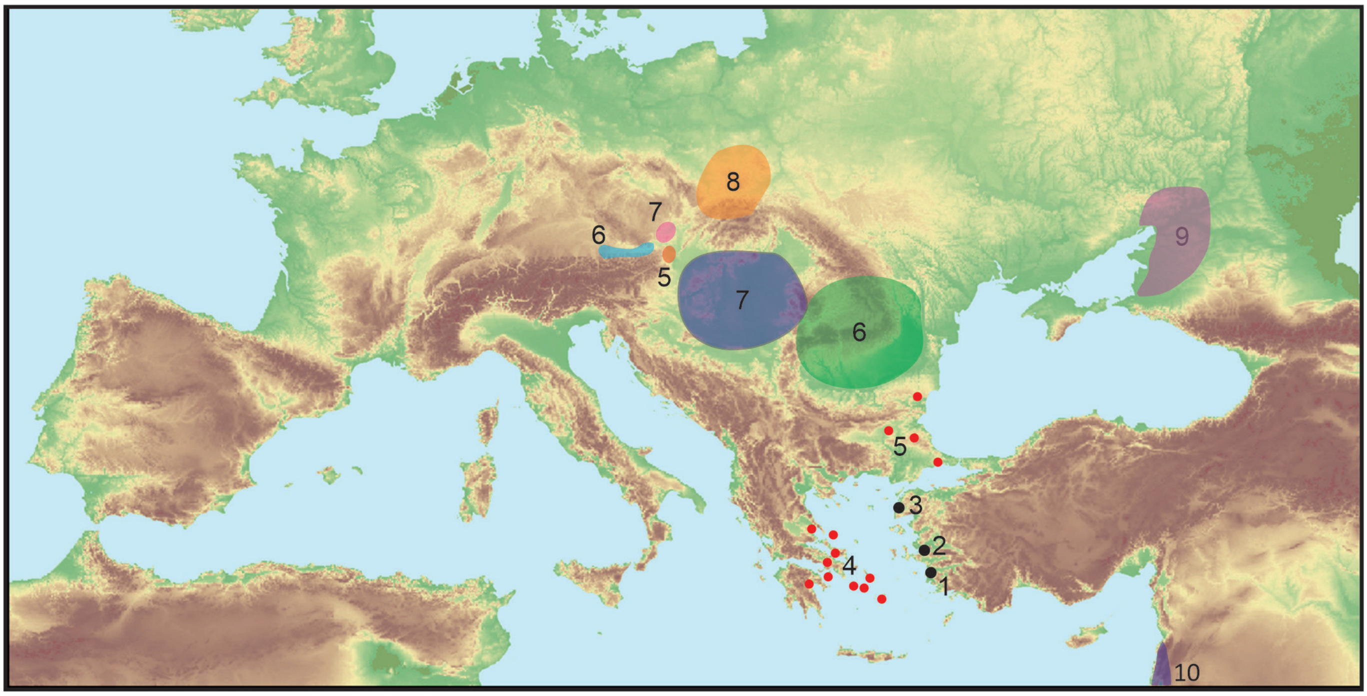


Fig. 2. Sites of EH IIb in Greece, A0 in Central Europe and the MBA beginning in Eastern Europe, 1 – Miletus, 2 – Liman Tepe, 3 – Troy, 4 – EH IIb in Greece, 5 – EB 3 in Bulgaria, 5 – Oggau-Ragelsdorf, 6 – Unterwölbing, 7 – Proto-Únětice, 8 – Chłopice-Veselé, 9 – pre-Donets (Azov) Catacomb culture, 10 – EB IV in the Levant.

In Troy IV and the subsequent period of Troy V, contacts with Greece and Cyclades disappeared, and relations with Liman Tepe near Izmir were very limited. The main trade relations of that time were focused on Northwestern, Central and Southeastern Anatolia. Contrary to this, to the south, on the Anatolian coast of the Aegean, the relations with Central Anatolia and Cilicia decreased[81]. Excavations in Kolonna/Aegina in the Saronic Gulf south of Attica show that initially, this settlement had intensive contacts with the Cyclades, the Northeastern and Southeastern Aegean, but with the beginning of EH III, the pottery of the Kastri/ Lefkandi I type appeared there. Beginning with that time, the settlement retained relations with the Eastern Aegean, but the relations with the Troad were completely absent until the period of Troy VI[82]. Probably, in the areas of Liman Tepe and Miletus, the Greek population had persisted, and later the Kingdom of Ahhiyawa was formed in the area. In contrast, the Troad was inhabited by the Thracians[83]. This difference could determine these directions of trade routes. Contacts of Troy were also focused on the Northern Balkans.

3.2. *Anatolian impulses in the Northern Balkans*

The role of Anatolian impulses in the formation and further development of the European Bronze Age cultures is beyond doubt, and the Bronze Age traditions advanced from the south-east (fig. 2)[84]. The earliest impulses were associated with the Greek migration, marked by the appearance of the Lefkandi I/Kastri ware in Eastern Greece in EH IIb. In the radiocarbon chronology it is dated from about 2450/2400 cal. BC, and in the historical one from ca. 24th century BC. It was a process of slow colonization, not a rapid migration[85], which does not allow us to use this date as a benchmark for all areas. The beginning of this colonization of Greece can be synchronized with the end of the Anatolian EB 2b, Troy II before Troy IIc, Beycesultan XIII, Karataş V, and its end(late EH II, transition to EH III) with the Anatolian EB 3a, Troy II-late and III[86]. In the Dhaskalio sanctuary, AMS dating with the Bayesian statistics has given the date of transition to the Kastri phase ca. 2609–2482 cal. BC, and to the subsequent EC III period ca. 2451–2322 cal. BC (95% probability)[87]. But these dates seem to be very early, contradicting the Trojan and European chronologies. The earlier dates in the Aegean might be connected with sea effects and volcanic activities[88].

Noticeable changes also occurred in Southern Thrace (Turkish Thrace and southeastern Bulgaria). Before this, the culture of Bulgaria (Mikhailich phase) had been identical to that of Troy I. But at this new stage, fortified settlements appeared, with adobe walls on stone bases and buildings of the megaron type. On many settlements (Mikhalich–Baa Dere, Altan Tepe, Cherna Gora, Mudrets, Assara, Kanlıgeçit, Dabene, Ezero, Gălăbovo, Koyunbaba, Selimpaşa) artefacts with Anatolian analogies have been found: pottery of the Lefkandi I/Kastri type, wheel-made ware, clay Anatolian idols, Syrian bottles, containers with high lids, amphorae, pilgrim flasks, a crescentic axe, spindle whorls. In Bulgaria, rich burials, gold, silver and bronze objects appeared. The bronze production grew. These innovations were numerous

[81] BLUM/RIEHL 2015, 185–189, 192, 198; BLUM 2016, 90, 93, 94, fig. 9.
[82] BERGER/GAUSS 2016, 222.
[83] GRIGORIEV 2022a, 26, 27.
[84] HEYD 2013, 55.
[85] GRIGORIEV 2022a, 37.
[86] MARAN 1998, 418–421; ALRAM-STERN 2004, 164, 172, 202, 361.
[87] RENFREW *et alii* 2012, 155.
[88] WIENER 2010, 371, 372.

and had parallels in Northwestern Anatolia. The presence of Anatolian pins indicates the changes of clothes and the appearance of a new fashion. Constructions of the Kanlıgeçit settlement, layer 2b, are identical to Troy IIc1-c3. Most authors associate this with the coming of people from Anatolia, or at least with the establishment of strong trade relations with this region. It corresponds to the Bulgarian EB 3, or Sv. Kirilovo phase[89]. Within the radiocarbon chronology, this phase is dated from 2400 cal. BC[90]or from 2500/2400 to 2200/2100 cal. BC, when the Middle Bronze Age started[91]. Thus, this complex is very close to the culture that appeared in the south with the coming of the Greeks. In Thrace, it appeared a little later (since the beginning of EH IIb in Greece preceded Troy IIc and this complex can be synchronized with the latest layers of Troy II), but before the beginning of EH III[92]. The newcomers did not completely replace the previous local population, since only 20% of the ware belongs to the Anatolian types, but they provided trade relations with the original areas in Anatolia, which was accompanied by flows of new migrants. Therefore, this model may be considered as a prototype of colonies, although it has not been definitively demonstrated[93]. As a matter of fact, the same model (and not a simple migration) has been reconstructed for Greece[94].

In Romania, the start of the EBA II is dated by the AMS method since 2500 cal. BC, but more likely since ca. 2400 cal. BC[95]. Therefore, the EBA formation began there earlier, but the transition to EBA II was probably contemporary to the described process.

3.3. *Carpathian basin and Central Europe (A0)*

The Anatolian impulses of the EH IIb period in the Balkans influenced the formation of the EBA cultures in the Carpathian basin, Central Europe and Northern Italy (fig. 2), where typical metal objects began to spread (triangular riveted daggers, halberds, flanged axes, necklaces, diadems, Nippenringe, crescents, pins), although it was more pronounced in the next stage. These influences were felt from the Balkans through the Carpathian basin[96], and they resulted in the appearance of the limited repertoire of relevant metal objects in some cultures (Bell Beaker, Epi-Corded, Oggau-Ragelsdorf in Lower Austria, Chłopice-Veselé in Poland and part of Slovakia, Proto-Únětice in a limited area of Moravia, etc.), which has made it possible to distinguish the phase A0. It was a slow process, driven precisely by influences. It is well expressed in the fact that local cultures inherited the former ceramic complex, although in some instances a repertoire characteristic of the Lefkandi I appeared. Social structures became more complicated, and the re-occupation of tell-settlements occurred[97]. The cultures of the Hungarian EBA 2 (proto and early Nagyrév, proto Kisapostag, Nyírség, early Maros) formed ca. 2300/2200 cal. BC or earlier, slightly predate the formation of the A0 cultures in Central Europe. Dates of this period have many contradictions, but based on the AMS dates it is supposed that the process began before 2200 cal. BC[98]. In Romania, it coincides with the sub-phase EBA IIb (Nagrév, early Mureș, etc.), whose AMS dates form the interval 2350–2250 cal. BC[99]. This was later than the changes in the Balkans but preceded the changes in the Danube basin.

3.3.1. *Other events contemporary to EH IIb, A0*

The penetration of Anatolian people into the Balkans and the transformations of the European cultural systems were not the only migration process of the mid-3rd millennium cal. BC. The spread of the Bell Beaker culture from the southwest to many European regions is well known. Probably, at the same time, the Catacomb culture in the North Pontic area formed, and the Eurasian Middle Bronze Age started. Its original area (pre-Donets or Azov culture) was small. It was located east of the Azov Sea, in the Lower Don and Lower Kuban areas[100]. Only in the next stage did Catacomb culture occupy all the steppes of Eastern Europe (figs. 2, 3). In my opinion, the roots of the catacomb rite should be sought in the southeastern Caspian. From there it (along with other features, such as burials contracted on their right side facing the shaft, stone partitions, burners, some metal objects, etc.) spread to Eastern Europe and Palestine[101]. The occurrence of this tradition in Palestine took place in the local EB IV. Previously, its beginning was dated ca. 2500 cal. BC, but the use of Bayesian statistics on the successive layers of Jericho made it possible to date the entire period to the interval 2300–2000 cal. BC, which is close to its historical dates – 2400/2300–2000 BC[102]. Thus, with any system, we have the dates close to the EH IIb time, although this does not mean their complete synchronization. This allows us to admit the presence of some incentive impulses for these events. It is not excluded that this migration could be have been caused by aridification started in Iran in the mid-3rd millennium cal. BC, but this supposition needs additional proof.

3.4. *Carpathian basin and Central Europe (A1)*

With the beginning of BrA1 and EH III, the European EBA cultures area expanded (fig. 3)[103]. The first phase of the EBA in Central Europe (Reinecke's phase BrA1: early Únětice,

[89] HEYD 2013, 20–24; LESHTAKOV 2014, 321–332; HRISTOV 2016, 229, 232, 235; HEYD *et alii* 2016, 172–193; ÖZDOĞAN 2016, 199–205; ALEXANDROV 2018, 91, 92; PAVUK 2018, 269–273.
[90] HEYD *et alii* 2016, 172.
[91] ALEXANDROV 2018, 91.
[92] I believed that this complex had appeared with the beginning of EH III in Greece (GRIGORIEV 2022a, 23). But its dating within the EH II-late is more probable.
[93] HEYD *et alii* 2016, 192, 193; ÖZDOĞAN 2016, 201, 206.
[94] GRIGORIEV 2022a.
[95] GOGÂLTAN 2015, 54, 62.
[96] HEYD 2013, 40.
[97] KRAUSE 2003, 55, Abb. 20; HEYD 2013, 43–47.
[98] FISCHL *et alii* 2015, 503–507, 513.
[99] GOGÂLTAN 2015, 54, 62.
[100] GEY 2011, 4, 5.
[101] GRIGORIEV 2002, 381–384. L.S. Klejn explained the appearance of the Mitannian Aryans and the catacomb rite in Palestine in the following way: "In Northern Iran, half way between the North Pontic steppes and Palestine, in Tureng-tepe (Deshayes, 1969: 14), catacomb burials of the newcomers were found, dated ca. 1700 BC (just the same time that is needed" (KLEJN 2007, 47). But this site is situated far from the hypothetical way of this migration, on the border between Iran and Turkmenistan, and in the cited publication the layer is dated ca. 2375±250 cal. BC. Therefore, it reflects only the old tradition of this rite in the southeastern Caspian.
[102] REGEV *et alii* 2012, 560, 561; NIGRO *et alii* 2019, 25, 28.
[103] KRAUSE 2003, Abb. 25.

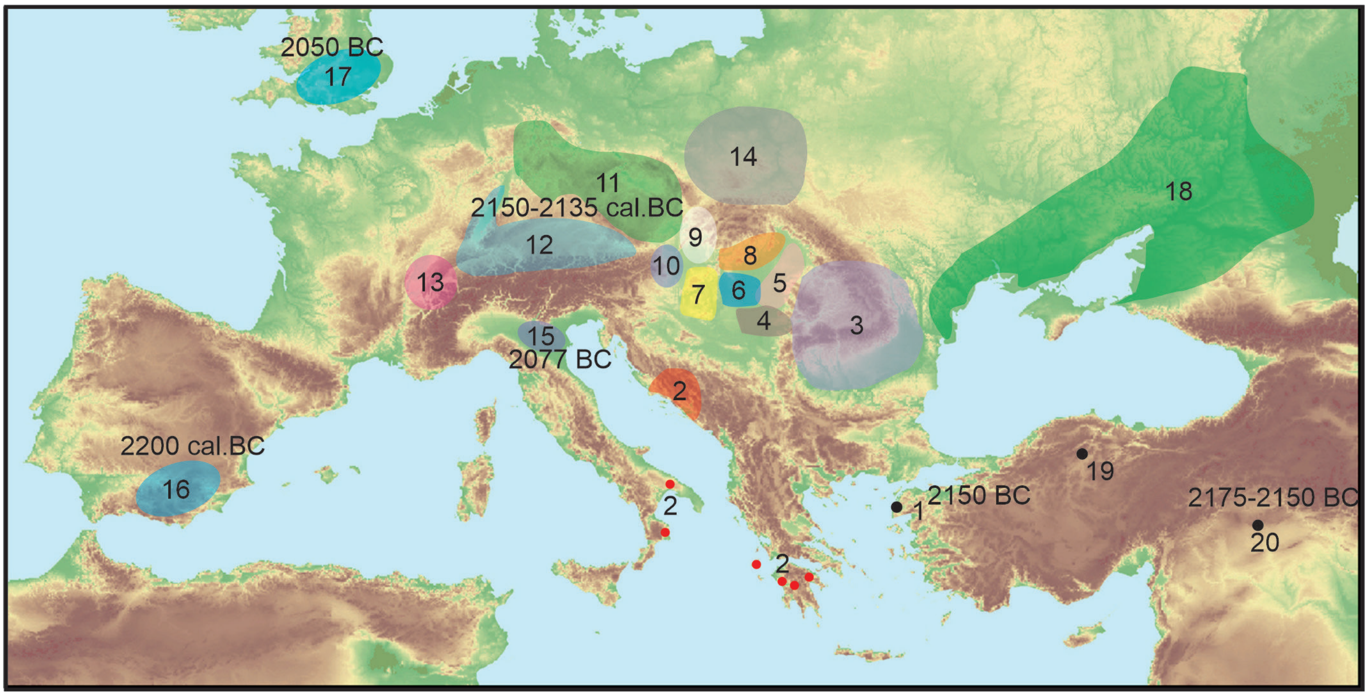


Fig. 3. Cultures of the EBA in Europe and the MBA in Eastern Europe, mentioned in the text: 1 – Troy III/IV, 2 – Cetina culture and its spread, 3 – EBA III in Romania, 4 – Maros, 5 – Otomani I, 6 – Late Nagyrév, 7 – Kisapostag, 8 – Hatvan, 9 – Nitra, 10 – Gáta-Wieselburg I, 11 – Únětice, 12 – North Alpine and Rheine groups (Adlerberg, Oberrhein-Hochrhein, Singen, Neckar, Ries, Straubing, Unterwölbling), 13 – Rhône culture, 14 – Mierzanowice, 15 – Polada, 16 – early El Argar, 17 – EBA 1 in Britain (phase Migdale/Butterwick), 18 – Catacomb culture, 19 – Resuloğlu, 20 – Tell Leilan.

Nitra, Unterwölbing, Straubing, Singen, Hatvan) is dated to about 2300–1900 cal. BC[104], but most dates fall in the interval between 2200 and 2000 cal. BC[105]. The radiocarbon dating of the transition to the EBA is complicated by two plateaus in the calibration curve ca. 2460–2200 cal. BC and 2200–2050 cal. BC, the accepted date 2200 cal. BC is conventional, but the analysis of the general situation suggests that the transition to the BrA1 phase occurred ca. 2150 cal. BC or even one generation later. However, it was not a synchronous process. Some A1 groups could begin their formation a little later[106]. The Bayesian statistics of closed complexes, which reliably belong to the particular Reinecke's phases, suggest the date for the BrA1 phase ca. 2135–1835 cal. BC[107]. Thus, we get a well-coordinated system: the beginnings of BrA1 and EH III may be placed within the third quarter of the 22nd century cal. BC, and they immediately followed the catastrophe of the Akkadian Kingdom, migrations in the Near East, the end of Troy III and the hiatus there. It is very difficult to verify this by dendrochronology, since the dates for this period are rare. In the Northern Alps, the earliest ones for the BrA1 phase appear ca. 2000 BC, and in the Western Alps ca. 1800 BC, i.e. the BrA2 phase[108].In Britain, the corresponding EBA 1 period (phase Migdale/Butterwick) is dated to 2300/2200–2000/1900 cal. BC, but there are two dendrodates 2050 and 2049 BC[109]. Accordingly, the continental phase BrA1 should begin earlier, and a date within the interval 2150–2135cal. BC or ca. 2135cal. BC is quite likely.

In the Carpathian basin, former cultural relations were broken at that time, which is explained by the coming of people of another origin[110]. In Hungary, new cultures are being formed (Kisapostag, Gáta-Wieselburg I, Late Nagyrév, Hatvan, Nyírség/Szaniszló, Otomani I, Maros), and new features appeared: fortifications on tell-settlements and a series of Anatolian parallels, including those in architecture. There are few modern dates for this period, and it is traditionally dated to ca. 2200–1900 cal. BC[111]. The transition to the EBA III in Romania belongs to this period too[112].

In the entire Danube basin further to the west, the EBA cultures were being formed (Unterwölbing, Straubing, Singen, Adlerberg), which inherited the former Bell Beaker traditions in funeral rites, house building, pottery, and even the genes of previous populations, but significant influences from the Carpathian basin and the Balkans are noticeable. Many innovations (above all, diadems, pins and torcs) had Near Eastern prototypes. New metal smelted of *Fahlerz* appeared[113].

Some other objects and traditions had probably also Anatolian origins. The burials in cists and pithos appeared, which were typical of Anatolia[114]. In the Resuloğlu cemetery (second half of the 3rd millennium cal. BC) in North-Central Anatolia, burials of these types contain

104 KRISTIANSEN/LARSSON 2005, 118.
105 KRAUSE 2003, 84; KIENLIN 2008, 23.
106 BERTEMES/HEYD 2015, 564, 575.
107 BRUNNER *et alii* 2020, 14.
108 KRAUSE 2003, 76, 77; DELLA CASA 2013, 711.
109 GERLOFF 2007, 125, 127, 140.
110 HEYD 2013, 17.
111 METZNER-NEBELSICK 2013, 332; FISCHL *et alii* 2015, 504, 508.
112 GOGÂLTAN 2015, 54, 62.
113 GERLOFF 2007, 130; HEYD 2013, 27; BERTEMES/HEYD 2015, 566–571, 573.
114 GRIGORIEV 2022a, 17.

ornaments widespread in the European EBA: pins with rounded or spherical heads, bracelets and rings of round wire, torcs, necklaces and beads of various forms made of different materials, including faience and cornelian. The most interesting are star and cross-shaped beads, especially those with four protrusions, identical to faience beads of the Straubing and Unterwölbing cultures. But these particular beads were made of cornelian[115]. Then, just this form penetrated from Central Europe into Babino culture[116]. But their area of origin was Anatolia.

A very important event at the beginning of this period was the spread of Cetina culture from the Northwestern Balkans to Western Greece and some areas of the Central Mediterranean[117]. Perhaps, it was caused by the pressure of people who came to the Danube region. But in other areas of Greece, we do not see any external impulses, and in EH III, the cultural traditions were spreading, which had begun their formation in EH IIb.

In Romania ca. 2000/1900 cal. BC, synchronously with the final part of the Central European EBA (BrA1c)[118] and the early MH in Greece, a transition to the MBA took place, with former cultures, which had appeared in the previous EBA IIb–III period (Mureș or Periam-Pecica), and new ones (Vatina, Otomani, and Wietenberg)[119]. The early Wietenberg culture sites in Transylvania are rare, but the contemporary cultures of the eastern Carpathian slopes in Romanian Moldova (Costișa and Monteoru) formed a little earlier (fig. 4). Their beginnings are dated ca. the late 3rd – early 2nd millennia cal. BC or within the interval 2200–1950 cal. BC. Since it is not their entire interval, but a confidence interval of their beginnings, it is later than the beginnings of the EBA III in Romania and Hungary, BrA1 in Central Europe and EH III in Greece. It is possible that the early Wietenberg I phase began before 2000 cal. BC, along with the later phase of the early Monteoru Ic3 period. In general, the local MBA I is dated to ca. 2202/2038–1880/1687 cal. BC[120]. Thus, despite the conditional character of these dates, we see a fairly clear picture: the traditions that formed the local MBA appeared initially in the final EBA to the east and south-east of the Carpathians, and since that time they began penetrating the Carpathian basin. Further along the Danube, there was no significant migration, the DNA of local populations (with the exception of Maros culture) being similar to those of the former Bell Beaker people. However, a faster cultural development started[121]. But we may assume penetrations of small groups, since in the Danube region, burials in pithos appeared, typical of Anatolia[122], although this might be regarded as a result of the previous Anatolian

[115] YILDIRIM 2006.
[116] LYTVYNENKO 2013.
[117] MARAN 1998, 14, 19, 23, 24; HEYD 2013, 47.
[118] J. BÁTORA(2000, 522, Abb. 692) suggested this sub-phase for Slovakia. It is characterized by the coexistence of the late Nitra culture with the pre-classical Únětice culture penetrated here from the west. In the Reinecke's periodization, it corresponds to the last third of the BrA1 phase, in the Ruckdeschel's periodization, to the second half of his sub-phase BrA1b.
[119] GOGÂLTAN 2015, 55, 70.
[120] BOLOHAN 2003, 195, 196; GOGÂLTAN 2015, 70, 74, 76, 77, fig. 23;MOTZOI-CHICIDEANU/ȘANDOR-CHICIDEANU 2015; PUSKÁS 2015, 105, 106, 108.
[121] BERTEMES/HEYD 2015, 573.
[122] BOUZEK 1985, 79; SELOVER/DURGUN 2019, 273–275.

impulse. However, there the process was mainly based on cultural influences, in contrast to the Carpathians. In the last region, in addition to the Wietenberg and Otomani-Füzesabony ornamental style, the migration is reflected in the emergence of chariots. The latter was connected with the early phases of Costișa and Monteoru, and is well visible in the first European cheek-pieces, which preceded the steppe ones in the Volga-Ural region. It is remarkable that the Carpathian chariots differ from those in the steppe and are identical to the Near Eastern ones, as their wheels had four spokes[123]. From Romania, this tradition spread further west and northwest.

In Slovakia, the contemporary sub-phase Br A1c is dated slightly later, ca. 1930–1870 cal. BC[124]. After this, the transition to the younger EBA phase, BrA2, took place (classical Únětice, Nitra, Unterwölbing, Straubing, Hatvan, Věteřov, Maďarovce), which is dated between ca. 1900 cal. BC and 1650 cal. BC[125]. In Britain, the contemporary (based on typological correspondences) phase EBA 2 (Wessex I) is dated between 2000/1900 and 1750/1650 cal. BC[126]. The Bayesian statistics of the AMS dates from closed complexes suggest for the BrA2 the interval 1865–1545 cal. BC[127]. Accordingly, we may place the sub-phase A1c within the 20th – first half of the 19th centuries cal. BC.

In Hungary, chariots and Carpatho-Mycenean ornaments appeared in the Otomani-Füzesabony culture in the EBA 3 and the following MBA period[128]. Further in

[123] GRIGORIEV 2021a, 166–168, 172, 173.

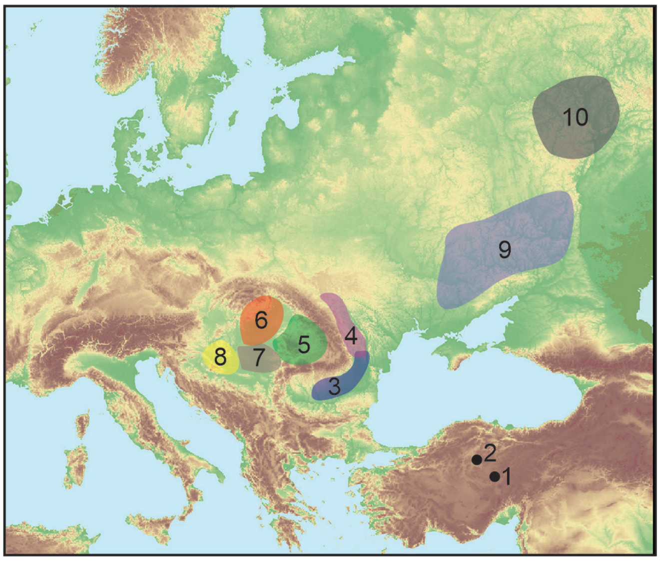


Fig. 4. Sites in Anatolia and cultures of the final EBA and early MBA of the Carpathian basin, final MBA cultures in Eastern Europe: 1 – Kültepe, 2 – Boğazköy, 3 – Monteoru, 4 – Costișa, 5 – Wietenberg, 6 – Otomani-Füzesabony, 7 – Maros, 8 – Vatina, 9 – Dnieper-Don Babino culture, 10 – Middle Volga Abashevo culture.

[124] BÁTORA 2018, 89.
[125] KRAUSE 2003, 78; KRISTIANSEN/LARSSON 2005, 117, 120.
[126] GERLOFF 2007, 125, 141.
[127] BRUNNER *et alii* 2020, 14.
[128] Some authors write about the appearance of domestic horses in the EBA 3 of Thracia, where in the Kanlıgeçit settlement their bones comprise 15%. These bones are present in phase 2 and the later phase 1 (HEYD 2013,

the west, in Southern Germany and Switzerland, the cheek-pieces are dated since the A2c sub-phase. These ornaments have exact analogies in Anatolia: in Kültepe (Kaniš) ca. 19th century BC, and in Boğazköy ca. 19th–18th centuries BC. Therefore, it is supposed that these Anatolian complexes were contemporary to the European phase A2[129]. However, their dates are in historical chronology; correspondently, within this chronology we may date the BrA1c beginning and the end of the Hungarian EBA 3 ca. 19th–18th centuries BC. Ornaments of this type are known in early Monteoru and Costişa, and their earliest finds have the AMS dates ca. 1745–1680 cal. BC(67.4% probability), but the layer Kültepe Ib with these ornaments is dated by dendrochronology and historical chronology since 1852–1843 BC. Based on this, I was inclined to date the Anatolian impulse to ca. 1850–1750 BC[130], which is even later than the date suggested by the Bayesian statistics. But this interval is based on rare finds, so any future finding can make the interval deeper. There are two dendrodates for the phase A2a (1942 and 1840 BC) from the Únětice culture burials in Leubingen and Helmsdorf[131]. Correspondently, they are earlier than the AMS dates.

From above said we may assume some Anatolian impulse to Europe at the beginnings of EH III and BrA1. It influenced the changes in metalwork and the appearance of burials in cists and pithos. There is no impression of a significant impulse with mass migrations, as it was limited to the Carpathians and some Danube areas. In most parts of Europe, there was a local development, with the formation of new systems of relations, and the process was not rapid. However, at the end of the EBA (at the transition to BrA1c) in the Carpathian basin, mainly in Romania, the second impulse took place, with chariots, horses and ornaments of the Anatolian-Carpatho-Mycenean type.

3.5. *Italy*

In the entire peninsular Italy, at the transition to the EBA (22nd – early 21st centuries cal. BC), cultural changes and, in some instances, depopulation are supposed. A possibility to synchronize these processes with the changes in the Balkans and the beginning of EH III is provided by the occurrence in Southern Italy and Sicily of elements of the Cetina culture. In their context, in Apulia and southeastern Sicily, specific bossed-bone plaques have been found, with parallels in Lerna and Troy[132]. The first lake-dwellings of the Polada culture in Northeastern Italy appeared later, which is confirmed by dendrodates since 2077± 10 BC[133]. However, in general, the culture may be synchronized with Lerna IV-late, i.e. with EH III[134]. Dendrodates divide it into three phases: EBA IA – 2077–1992 BC, EBA IB – 1985–1916 BC, and EBA IC – 1869–1859 BC. Two latter phases are synchronized with the Central European phase BrA2[135], although there is no guarantee of a full synchronization. Thus, we may suppose that the process of the EBA formation in Northern Italy started with a delay, as the most probable date for its beginning in the Danube region is the third quarter of the 22nd century BC. We cannot exclude that the dendrodates for the earliest Italian complexes have not been found yet. The application of the Bayesian modelling to 79 dates shows the superimposition of periods, the beginning of the Italian EBA within the interval 2253–2146 cal. BC, and the latest Bell Beaker complexes (for which dendrochronology is absent) belong to the interval ca. 1981–1628 cal. BC[136]. But it is even earlier than the Central European interval obtained by the same method. So, there are some problems (possible use of the LSC dates in the statistics?). This makes us be cautious even with the intervals based on the Bayesian statistics. Besides, the partial merging of the intervals of the Bell Beaker and Polada cultures is remarkable. It reflects a common European situation, when the later stereotypes could coexist with the previous ones for a long time, and the processes of cultural transformation were not impetuous.

Already the early Polada complexes include large cordoned vessels with Central European analogies. Perhaps, even some Bell Beaker inclusions were not local, but brought from Lower Austria and Southern Germany. There are some features in the funeral rite (for example, bipolar burials) similar to those in the groups of Straubing, Adlerberg, and Singen[137], i.e. the features that allowed Babino culture to be compared with Polada and these Central European groups[138]. For this reason, I supposed that the formation of the Babino and Abashevo cultures in Eastern Europe may be synchronized with the beginnings of Polada and EH III, because the coming of migrants into the Carpathian basin had made a part of local people migrate[139]. However, there is no guarantee of the full synchronization of the processes. Despite the Central European impulses Polada had being

20; HEYD *et alii* 2016, 179; ÖZDOĞAN 2016, 205), although in Greece the horses did not appear with the same cultural complex. Moreover, the appearance of the domestic horses was always accompanied by the appearance of chariots (GRIGORIEV 2023). But in phase 1 the settlement was destroyed, new fine wares with metallic luster appeared, with analogies in Central Anatolia. And, the horse skulls have been found in a large pit that has been attributed to layer 2. This pit was situated right in front of the entrance to a large megaron, blocking it (ÖZDOĞAN 2016, 202–205). Such a location of the pit just near the entrance to the prestigious building is doubtful; it probably belongs to the time after the destruction of the layer ٢ of the settlement. Therefore, the appearance of horses in Thracia may be dated to this period. However, in the Hungarian EBA 2, which is chronologically close to the Thracian EBA 3, many horse bones have been found in the Budapest area, and an independent center of horse domestication is suggested (FISCHL *et alii* 2015, 515). This evidence needs checking, but it is possible, as in the Near East the horse domestication was carried out in the 3rd millennium BC, and initially horses were used to cross them with donkeys, to produce mules (GRIGORIEV 2023). It is remarkable that the first rare horse bones appear in Greece and Macedonia in EH III, as well as in the Thessalian MBA (Tiryns, Kastanas, Mesimeriani, possibly a tooth from Lerna IV, Argissa, Pevkakia), but there are also individual donkey bones (Lerna III, Pentapolis) (MARAN 1998, 241, 242, 244, 247, 256; COLEMAN 2000, 123; ALRAM-STERN 2004, 224, 225; DREWS 2017, 181). However, the evidence of chariots in the Carpathian basin are contemporary to the Carpatho-Mycenean ornaments, and they may not be dated before the late part of the Hungarian EBA. Therefore, a probable cause of this phenomenon is that the bones belong to the very end of this phase, or even very beginning of the next one, when old stereotypes persisted in some places of western areas.

129 METZNER-NEBELSICK 2013, 337, 338.
130 GRIGORIEV 2021a, 181.
131 BECKER *et alii* 1989.
132 PACCIARELLI *et alii* 2015, 253–257, 259, 270.
133 HEYD 2013, 49.
134 MARAN 1998, 375; ALRAM-STERN 2004, 212.
135 NICOLIS 2013, 694.
136 LEONARDI *et alii* 2015, 291.
137 LEONARDI *et alii* 2015, 286, 291, 295.
138 LYTVYNENKO 2013.
139 GRIGORIEV 2022a, 16.

formed on the base of local substrates. But this influence is noticeably higher in the next phases, when there are parallels with the Gata-Wieselburg group, which has made it possible to discuss the influx of people from the Danube basin[140]. Thus, based on the Italian dendrodates, the interval for the Babino beginning can be placed after the early 20th century BC. The only question is: if we may synchronize these events, as there is no evidence that these Danubian impulses started at the very beginning of the Italian EBA IB? A possibility remains to synchronize it with the periods when the European influences in Italy were at their maximum, because Babino can be synchronized with the sub-phase A1c. Therefore, the probable interval for the beginning of Babino culture within the Italian dendrochronology is 1985–1859 BC.

3.6. *Iberia*

In Iberia ca. 2200 cal. BC (dates based on the Bayesian statistics), the El Argar culture appeared, with burials in rock-cut tombs, stone cists and ceramic urns. Similar funeral rites had not been known in the previous period, but had been well presented in the Eastern Mediterranean and the Balkans. There are also fortifications with analogies in Troy I and Kolonna/Aegina and new types of weapons (halberds and riveted daggers). Initially, this tradition appeared in a relatively small area, but it spread gradually, and it is supposed that these changes were driven by eastern impulses. A more detailed approach shows that the East Mediterranean impulse originally took place, and this culture arose between 2200 and 2000 cal. BC (moreover, in the estimation of the chronological interval, the LSC and AMS dates are used together), and then, ca. 2000 cal. BC, the area had some relations with Italy, from where the tradition of halberds was brought[141]. The latter is also quite consistent with the later appearance of the EBA tradition in Italy.

4. DISCUSSION

4.1. *Benchmarks within the dendro- and historical chronologies*

The evidence for the different areas above allows them to be united in a system that may be used as a basis for the dating of Eastern European complexes. The chronological benchmarks are placed in Table 1. They are based mainly on the Near Eastern historical chronology, dendrochronology and the Bayesian modelling of AMS dates. As a result, we have a rather concordant system, in which only the dates for the beginnings of El Argar in Iberia and phase A2a in Leubingen are earlier compared to expected, and the dates of ornaments in Kültepe Ib are later.

The conventional date of the Greek migration at the beginning of EH IIb is 2450/2400 cal. BC, although in historical chronology we may suppose the 24th century BC and synchronize it with the appearance of Catacomb complexes in Eastern Europe.

[140] NICOLIS 2013, 695.

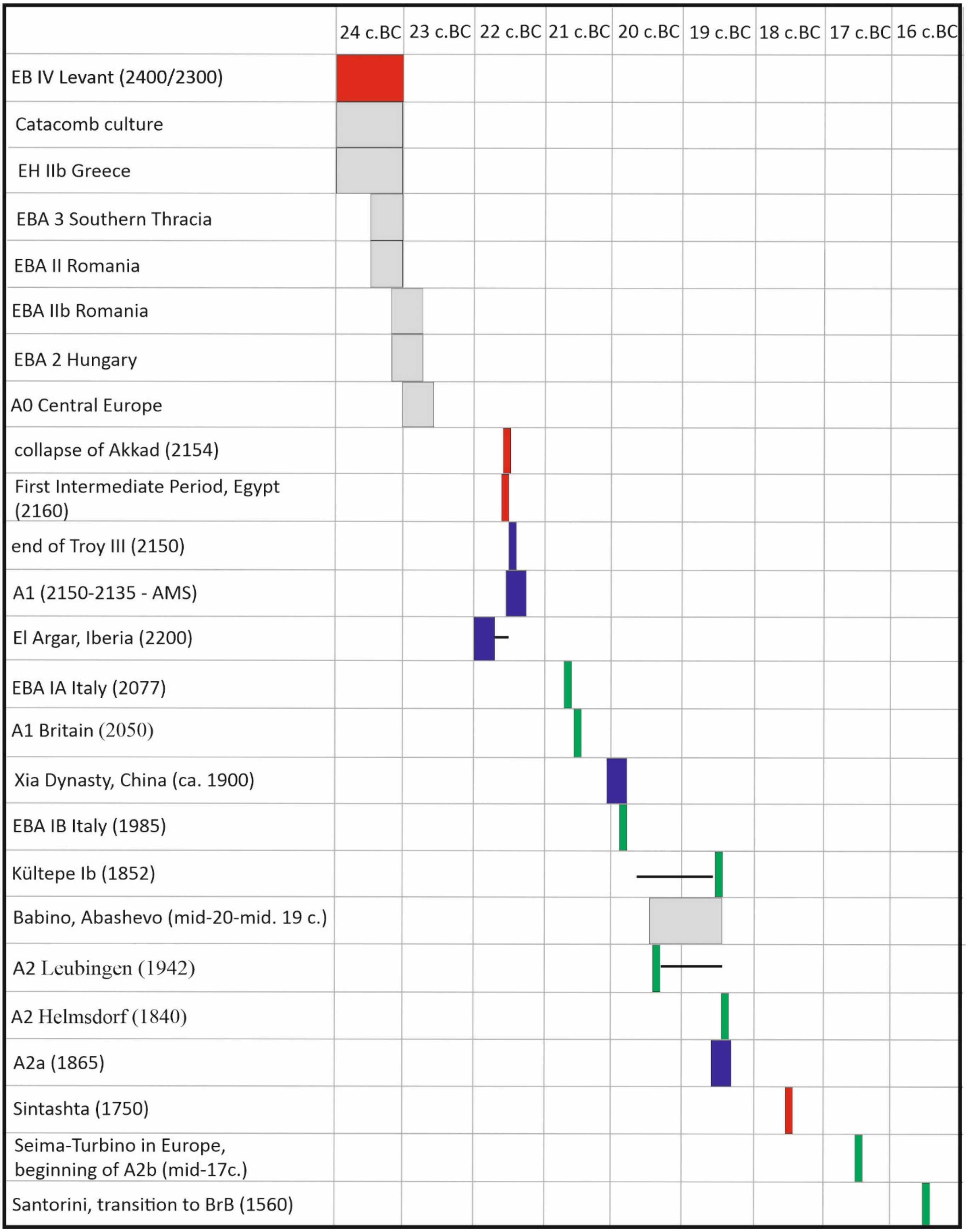
[141] LULL *et alii* 2013, 283; LULL *et alii* 2015, 369, 376, 377, 389–391; LULL *et alii* 2017, tabl. 1, p. 150, 151, 153, 158.

The most probable date for the transition to Reinecke's A1 is ca. 2150 BC or slightly later. It is close to the collapse of the Akkadian Kingdom, whose last king Shu-turul ruled until 2154 BC, and at the same time a long drought began that affected this collapse. The beginning of the First Intermediate Period in Egypt (2160 BC) is also close to it. This also corresponds to the beginning of EH III and the end of Troy III ca. 2150 BC, after which the settlement was abandoned for a long time[142]. Taking into account the Anatolian impulses in Europe in this period, we may assume migrations of people, at least up to the Carpathian basin. Further to the west, this process spread more slowly, in the form of influences, and the beginning of BrA1 can be dated in different areas within the third quarter of the 22nd millennium BC. Since the formation of Polada culture was influenced by impulses from the Danube region, it explains the later date of the EBA beginning in Northern Italy ca. 2077 BC, although it is possible that settlements with earlier dates have not yet been found.

For the Eastern European chronology, the most important is the beginning of phase A1c, which can be synchronized with the formation of Babino and Abashevo cultures. The Bayesian statistics of AMS dates suggest the A1/A2 transition ca. 1876–1820 cal. BC, so the A1c beginning may be dated within a broad diapason from the late 20th century cal. BC and within the first half of the 19th century cal. BC. If based on dendrochronology of the Polada culture in Northern Italy, the probable interval is 1985–1859 BC. The formation of the Carpathian MBA and cultural transformations caused by the coming of some groups with chariots and Carpatho-Mycenean ornaments can be dated to ca. 1850–1750 BC, if based on the Anatolian chronology, but possibly somewhat

[142] It is necessary to discuss some contradictory dates based on the Bayesian statistics, obtained for the Dhaskalio sanctuary on the island of Keros and the Kolonna settlement on the island of Aegina. In the first case, the transition Dhaskalio Phase A/B is dated to 2609–2482 cal. BC. Since the phase B corresponds to the early Kastri group, this date may be considered as the beginning of EH IIb/EC IIb, when the Greeks appeared. The transition Dhaskalio Phase B/C is dated within the interval 2451–2322 cal. BC, and this corresponds to the beginning of EC III/EH III. The transition to MH (end of phase C) is dated within 2387–2193 cal. BC (RENFREW *et alii* 2012, 147–155). In Kolonna/Aegina, the EH/MH transition is dated within 2191–2064 cal. BC, and the MH/LH transition – 1742–1623 cal. BC (WILD *et alii* 2010, 1019). Thus, we obtain much deeper dates for all the periods. But it contradicts not only the dates from the Hellas, but also the dates from Troy and Central Europe. It is doubtful that synchronizing EH III with the Reinecke's phase A1 we may date the latter period to 2451–2322 cal. BC. Since the Cycladic Kastri phase (and correspondently EC IIb and EH IIb) were in general synchronous to Troy II and III, the end of Troy III ca. 2150 BC does not fit into these intervals. Therefore, it is supposed that such early dates were caused by an effect of old tree, and they can be older by 50 years. In this case, the end of phase Dhaskalio B (and the transition to EH III, as well as the end of Troy III) may be dated to ca. 2354 ± 54 cal. BC, and the end of phase Dhaskalio C (and early MH) – 2267 ± 54 cal. BC. But even if we assume the 100-year effect of the old tree, the chronological gap will remain. As a result, it is assumed that EH IIb may be dated from 2400 cal. BC to 2300 cal. BC, the beginning of EH III – up to 2200 cal. BC, and Troy III ended before 2100 cal. BC, probably ca. 2175 cal. BC (JUNG/WENINGER 2015, 208, 215, 217–222). In this case, we have earlier dates for the beginning of EH III than the end of Troy III and the beginning of BrA1 in Central Europe, although the gaps will not be so large. As a result, the climate influences on the significant general cultural changes at the transition to EH III are in question (JUNG/WENINGER 2015, 222). But there is the problem only in this series of dates. A possible reason is the above mentioned possibility of some older dates in the Aegean, in some coastal and volcanic areas (WIENER 2010, 371, 372).

Tab. 1. Probable intervals for the beginnings of cultures and phases within historical chronology (red intervals), dendrochronology (green intervals) and Bayesian modelling of AMS dates (blue intervals), and reconstructed intervals (grey). Horizontal lines show deviations and probable errors.



earlier. There is one contradiction: two dendrodates from Leubingen and Helmsdorf, belonging to BrA2a – 1942 BC and 1840 BC. A possible explanation is that the BrA2 stereotypes started their formation in the Únětice area.

I was inclined to synchronize with the phase A1c not only the Babino and Abashevo cultures, but also Sintashta culture in the Urals, although the latter has few parallels in Central Europe (only metal rings, grooved pendants in 1.5 revolutions, and some bone objects). But their European analogies were in use during a very long time[143]. Cultures of the Babino and Lola circles (in sum, there are six regional cultures) are united into the post-Catacomb block. Each of them has three stages and all the stages have been synchronized to each other based on individual finds of similar objects. Their earliest stage has been synchronized with the early Abashevo culture in the Middle Volga region. Previously the number of radiocarbon dates for this block was rather limited, but now it is presented by 92 dates that form the interval ca. 2200–1800 cal. BC, and only its late part (3rd stage) is synchronized with the Sintashta interval[144]. However, in this statistics, the LSC and AMS dates are used together; there are only 35 AMS dates, and the dates of all six post-Catacomb cultures are calculated together, although it is not sure that all of them may be synchronized. The suggested interval corresponds to the early part of the European EBA, which has no typological confirmations. Partly, it is determined by the plateau in the calibration curve. But, as there are late Catacomb and early Lola inclusions in Sintashta, and its coexistence with Abashevo was supposed, the beginning of all these cultures was synchronized with the sub-phase A1c[145]. However, the radiocarbon dates show the beginning of Abashevo in the Middle Volga region within the interval 2128–1959 cal. BC, and the entire Sintashta period is placed within 1960–1770 cal. BC. But the Sintashta interval is provided by many AMS dates, and the situation with Abashevo interval is worse[146]. However, Abashevo formed before Sintashta. Babino cultures, judging from their chronology, too. It is possible to assume the same for the Lola cultures, but this will mean that their internal periodization is not correct. Moreover, at the same time, the late Middle Don Catacomb culture existed, which has some analogies in Sintashta. Accordingly, this destroys the basis under the idea of the "post-Catacomb horizon", which replaced the Catacomb cultures everywhere in the Eastern European steppe, since it is believed that the third stage of this horizon was synchronous to Sintashta.

In sum, as the Sintashta culture in historical chronology is dated from the mid-18th century BC (soon after 1750 BC), the difference between its beginning and that of Babino can be significant. Within the European periodization, the Sintashta beginning may correspond to the phase A2, although direct parallels are very limited. It is possible to suppose that the migration of tribes resulted in the formation of Babino started soon after the appearance of the chariot complex in the Carpathian basin, since this tradition and ornaments of the Carpatho-Mycenaean style were distributed in many cultures, but they were absent in Babino. An exception is the Pologi mound with its extraordinary find: a crook with metal covering decorated with so-called "bucrania" and flat meanders filled with rows of points. This complex provoked debates, but more justified is the opinion that it belongs to the early Dnieper-Don Babino culture, which has been supported by a series of AMS dates: 2200–1930 cal. BC[147]. It was supposed that the crook is the earliest object of the Carpatho-Mycenaean style[148]. However, the similarity of chronological intervals of Babino and the Carpathian cultures with chariots does not allow such a conclusion to be drawn. Since most of the Babino cultural features and funeral rites had roots in Central Europe, its formation was a result of migration from this region[149]. This crook could not appear in Eastern Europe before the appearance of this ornamentation in the Carpathians. Ornaments in the form of bucrania are unknown in the Carpatho-Mycenaean style. Similar meander is absent on the Mycenaean objects but is very typical on the bone tubes and pommels in the Carpathians (Deršida, Tószeg, Tizsafüred) and Anatolia (Kültepe)[150].

Thus, the formation of Babino culture was connected with migration that had been caused by the coming of Anatolian people with the chariot complex to the Carpathian basin. This, along with typological evidence, is the basis for synchronizing the Babino beginning with the beginnings of Monteoru and the sub-phase A1c. Correspondently, in historical chronology, this may not be dated to the 22nd century BC, as the radiocarbon dates suggest, because the appearance of the A1a complexes should be dated to the middle of this century. As a result, the probable interval of dates is the mid-20th – mid-19th centuries BC. To do it more accurately, a very difficult work is needed: a detailed comparison of Babino materials with those in Central and Southeastern Europe and Northern Italy, and additional links to the Alpine dendrochronology. Perhaps, the cultures of the Lola circle started their formation within the same interval, but further investigation of this problem is possible only by indirect links with the Near Eastern chronology through the Transcaucasian materials. And, it is very doubtful that the Babino and Lola cultures were formed simultaneously. Besides, in many areas, the Catacomb enclaves existed during a long time. Otherwise, it is impossible to explain the presence of Catacomb features in Sintashta.

4.2. *Historical processes*

It is absolutely obvious that the dates proposed on the basis of dendro- and historical chronologies need further essential improvements. They may be considered as approximate benchmarks that allow separate parts of this chronological system to be improved. However, already at this stage, we see causal relationships and relative speed of the processes of cultural transformation in particular regions. The changes in Europe in the second half of the 3rd–early 2nd millennia BC were stimulated by orbital changes. The latter began ca. the middle of the 3rd millennium BC, the weakening of the Asiatic monsoon started, and the first

143 GRIGORIEV 2019.
144 MIMOKHOD 2022.
145 GRIGORIEV 2018; GRIGORIEV 2019, 235, 236.
146 EPIMAKHOV 2020.
147 LYTVYNENKO 2020; MIMOKHOD *et alii* 2020, 103, 106; OTROSHCHENKO 2020.
148 OTROSHCHENKO 2020, 135, 136.
149 LYTVYNENKO 2013.
150 DAVID 2001, Abb. 7.

phases of a drier climate are recorded in the Middle East. In the 24th century BC this led to migrations of people with the catacomb burial tradition from the southeastern Caspian region to the Levant and Eastern Europe. It is possible that this movement affected the displacement of the Greeks from Northeastern Anatolia to the west, although some local arid phases could also be the cause. However, chronologically it was the same period, and we may synchronize the beginnings of the MBA in Eastern Europe and EH IIb in Greece.

The initial impetus for the formation of the A1 cultures in Europe was a natural disaster somewhere in Eastern Anatolia in the second quarter of the 22nd century BC. It provoked migrations in the Near East, the collapse of the Egyptian Old Kingdom ca. 2160 BC and of the Akkadian Kingdom ca. 2154 BC, and, ca. 2150 BC, it interrupted life in Troy. Soon after that, the migrations to Europe followed, as a result of which, within the interval ca. 2150–2135 BC, the formation of the EBA cultures began in Central Europe. Then, from this region, the impulses to the south formed the Italian EBA no later than 2077 BC. It is perhaps no coincidence that the earliest date of the British EBA is 2050 BC, and soon after halberds of Italian origins appeared in the El Argar culture. Thus, we see the later advancement of the tradition to the remote regions (if there will be no earlier dendrodates), and it is not excluded that this had some causes in Central Europe. A deviation from this is the relatively early, ca. 2200 cal. BC, emergence of the EBA tradition in southeastern Iberia. Taking into account that the date is based on Bayesian modelling, it is close to the very beginning of the process. The analogies of the El Argar culture in the east make it possible for a maritime migration of some small group to be assumed.

This speed of the EBA tradition distribution may only be explained by migrations, which were accompanied by the formation of a new system of relations and cultural influences. Thus, we see a well-balanced system of dates linked to the absolute chronology (Table 1). It perfectly fits into the ideas about the gradual penetration of the European Bronze Age traditions from the southeast.

The second Anatolian impulse to Europe was not so large-scale, and it was limited by the Carpathian basin, where people with the chariot tradition came from Anatolia. We do not know of natural disasters for this period that could trigger the process. Most likely, it was caused by the political situation in Anatolia, where small kingdoms were being formed, and they were fighting for resources and control over trade routes. This led to the next cultural transformations and the displacement of some parts of the former Danube populations to Northern Italy and Eastern Europe. But in this case, we do not have a balanced system of dates, since the Near Eastern chronology suggests the middle of the 19th century BC, and the Italian dendrochronology, 1985–1859 BC. Therefore, the likely interval is the second half of the 20th – first half of the 19th centuries BC.

One more chronological benchmark for the connection of Central European and Eurasian chronologies is the westward penetration of the Seima-Turbino bronzes, which occurred in Europe at the beginning of the sub-phase A2b, or ca. the mid-17th century in the Alpine dendrochronology. Finally, the epoch ended in all the regions ca. 1560 BC, after the catastrophic Santorini eruption[151].

4.3. *Methodological notes*

The improvement of the chronological system linked to the dendro- and historical chronologies will be accompanied by difficulties arising from the nature of the processes. In rare instances, a mass migration resulted in an instant change of the cultural complexes, as was the case with Sintashta culture in the Urals at the MBA/LBA transition. But the following spread of Sintashta stereotypes took a long time. In Eastern Europe, we see their partial coexistence with the late MBA complexes (post-Catacomb and late Catacomb, which were also partly contemporary). Even in different areas of small Greece, traditions of EH II and EH III and those of EH III and MH existed at the same time[152]. In the North-western Pontic region, traditions of the Budzhak group of the EBA (Yamnaya culture) survived until the Babino formation[153]. In some areas of Poland, enclaves of the Funnel Beaker culture existed in the following period of the Globular Amphorae culture, enclaves of the latter coexisted with the Corded Ware cultures, and some traditions survived until the Trzciniec period[154]. The processes of cultural genesis were very slow. As a result, a direct comparison of artefacts from two areas does not always give the possibility for an accurate synchronization. Therefore, the way of comparing a system of processes proposed here will allow us to achieve better accuracy only if a constant correlation of the whole system is performed. Bayesian statistics can be used to verify the absolute dates based on historical chronology and dendrochronology, but only in case of its correct application. It is also necessary to understand the limitations of this way. It will allow the chronological benchmarks to be identified in the cases where new stereotypes were brought to an area as a result of migration. However, even here, we will have a lot of pitfalls. With a few exceptions, most of the migrations were not a one-time coming of a new group. Very often, it could be a penetration of a small group which saved relations with the original area. As a result, in the new area, artefacts could appear that had been developed in the original area after the initial migration. If we do not take into account (or assume) such a possibility, we inevitably will date this migration to a later time. There can be a lot of specific situations, and their variability will not allow an absolutely accurate system to be created. Besides, the preservation of old traditions inevitably led to the fact that the cultural complexes that we used to regard as consecutive had in reality partly coexisted. Nevertheless, the proposed chronological benchmarks will be gradually replenished with new ones, each year we will have new dendrodates and high-resolution paleoclimate data, and, step by step, it will allow us to create for Eurasia a unified system of absolute chronology.

Obviously, during a long time we will have difficulties with the dating of many cultures in this way. Besides, there

151 GRIGORIEV 2018a; GRIGORIEV 2022.
152 GRIGORIEV 2022a.
153 IVANOVA 2020, 51.
154 CZEBRESZUK 1991, 115, 116, 126; CZEBRESZUK/SZMYT 2008, 221; CZEBRESZUK/SZMYT 2012, 169, 170.

is no possibility to create a chronology based on Bayesian statistics for all the areas. Moreover, not many cultures are provided (and will not be provided in the nearest future) with reliable series of the AMS dates, and colleagues have to use the accumulated LSC dates. Therefore, their mixed use is absolutely unacceptable, even more their use together in statistical procedures, and we have to deal with several different chronological systems: 1) historical chronology, dendrochronology and Bayesian statistics of AMS dates, 2) AMS dates, 3) LSC dates.

5. CONCLUSIONS

The use of dendrochronology, historical chronology and Bayesian statistics of AMS dates gives comparable intervals of archaeological cultures that are younger and shorter than those suggested by conventional radiocarbon chronology. The fact that these independent data are comparable demonstrates their correctness. It is also indicative that, with rare exceptions, the system of these intervals for different periods between the mid-3rd and mid-2nd millennia BC has almost no internal contradictions (Table 1).

Cultural changes in Europe in the second half of the 3rd–early 2nd millennia BC, which covered huge spaces and were relatively synchronous, would have been impossible without large-scale migrations. These migrations were driven by orbital changes that caused the climate drift towards drier and cooler conditions in many areas. In its initial phase, it provoked the migrations of the 24th century BC from arid areas of the southeastern Caspian region, which allows this date to be used as a chronological benchmark for the transitions to EB IV in the Levant, MBA in Eastern Europe, EH IIb in Greece, EBA 3 in Bulgaria, EBA II in Romania, with some delay (contemporary to the Romanian EBA IIb) EBA 2 in Hungary and the phase A0 in Central Europe.

In most of the areas, the climate drift was not so significant to make people migrate. But the general process of climate deterioration was complicated by a volcanic catastrophe of the second quarter of the 22nd century BC in Eastern Anatolia. It aggravated the process, led to the destruction of many cultures and civilizations, and caused turbulent migrations in the Near East, which soon spread to the European continent. It gives us a new chronological benchmark for EH III and the BrA1 cultures in Central Europe: ca. 2150 BC. This resulted in the distribution of the EBA traditions in Europe, which was not instantaneous but took about 100 years until the mid-21st century BC.

The third Anatolian impulse took place ca. the 20th or the first half of the 19thcenturies BC, and it led to the appearance of the A1c cultures, the final EBA in the Carpathian basin, and EBA IB/C in Italy. The following internal processes led to the formation of MBA cultures in the Carpathian basin and stereotypes of the A2 phase in Central Europe. With some delay, but not too much, impulses to Eastern Europe followed, which formed the Babino and Abashevo cultures.

The fourth Anatolian impulse reached the Southern Urals (Sintashta culture) soon after the middle of the 18th century BC. Probably, not long after, the Seima-Turbino sites, Petrovka complexes of Kazakhstan and early Alakul culture of the forest-steppe Transurals appeared. It is impossible to synchronize this impulse with the European cultures, but it probably occurred during the sub-phase A2a, and not from its beginning. Within the phase A2, it is possible to distinguish the sub-phase A2b, when ca. the middle of the 17th century BC, the Seima-Turbino tradition penetrated Central Europe, which was obviously later than the Sintashta formation.

Finally, the European EBA ended its existence ca. the middle of the 16th century BC, which coincides with the Santorini eruption in 1560 BC. In Eastern Europe, it coincides with the spread of Srubnaya sites, and to the east of the Urals with the westward spread of the Fyodorovka (Andronovo) tradition from the Altai across the forest-steppe, and with the migration of the Alakul tribes into the steppe.

The proposed chronological benchmarks are preliminary, and their clarification–addition of new benchmarks will require much effort, and the obtained dates will be slightly different from one area to another.

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