

## NEW CHRONOLOGICAL FRAME FOR THE YOUNG NEOLITHIC BADEN CULTURE IN CENTRAL EUROPE (4TH MILLENNIUM BC)

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**ABSTRACT.** The Baden Culture is a widely spread culture of the Young Neolithics in east-central Europe. In southeast Europe, several parallel cultures are found at different places. The main innovations in east-central Europe associated with the Baden Culture were traditionally thought to originate in southeast Europe, Anatolia, and the Levant. However, in recent years, doubt about this theory has arisen among archaeologists.

Here, we try to contribute to this question by increasing the radiocarbon data set available for the Baden Culture. Thirty-two age determinations of samples from different sites assigned to the Baden Culture were performed by accelerator mass spectrometry (AMS) <sup>14</sup>C dating. The new data were combined with previously published <sup>14</sup>C dates. Data from the individual cultural phases of the entire Baden period and the parallel cultures in southeast Europe (Sitagroi, Cernavoda, and Ezero) were analyzed by sum calibration. Comparison of the results indicates that the southeastern cultures cannot be synchronized with the Boleráz period, the early phase of the Baden Culture. It seems that these cultures were parallel to the Baden Classical period. This finding, which has to be verified by more data from the southeastern cultures, contradicts the theory of the east-west spreading of these cultures.

### INTRODUCTION

During the Young Neolithic period around 4250–2850 BC (according to the central European chronology) principal progress was made in various fields of cultural and economic life. In this period we find the first occurrence of wheeled vehicles, an enormous step forward in the cultural development and exchange systems. The importance of this innovation is documented by models of wagons made from ceramics found as grave goods. In central Europe, a change occurred in the species of domestic sheep to a bigger form of wool sheep that was probably raised in the Anatolian region. The decoration of ceramics originating from this period shows that typical characteristics and similar features are found in various sites throughout southeast Europe (Kalicz 1963; Němejcová-Pavúková 1981). Archaeologists had assumed that the origin of these cultural innovations was in southeast Europe, Anatolia, and the Levant. It was believed that they spread from there to east-central Europe. However, over the last few years, archaeologists have begun to doubt this theory (Breunig 1987; Maran 1998).

Using radiocarbon dating, we compared the time periods of some of the so-called parallel cultures in southeast Europe with the chronology of the Baden Culture in east-central Europe.

### The Baden Culture

The Baden Culture is a widely spread Young Neolithic culture in east-central Europe. It is named after the “Königshöhle” near Baden, Lower Austria, where the remains of this culture were discovered for the first time.

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The Baden Culture is characterized by a typical design of pottery. As in the other Young Neolithic cultures, Baden people already used wheeled vehicles. Ceramic models of wagons were found in graves from the Baden period in Hungary (e.g. Foltiny 1959; Kalicz 1976). During the Baden period, the burial mode had been changed from cremation to burial of the body with funeral rites. The earliest signature of a trephination found so far in Austria was on a skull from the period of the Baden Culture (Heiling-Schmoll 1985).

#### Phases of the Baden Culture

The Baden Culture is divided into two large phases. The earlier one is called *Baden-Boleráz* after the *locus typicus* near Trnava in Slovakia. Ceramics from this period typically have brown surfaces in different shades and are decorated with herring-bone patterns. The Baden-Boleráz phase is followed by the so-called *Baden-Classical* period. One of the main characteristics of ceramics from that period is mugs with dark surfaces and handles extending far above the rim.

Archaeological evidence shows that the two main stages were further divided into a number of consecutive phases of development (Baden Ia–c, IIa–b, III, IVa), which are characterized by, among other things, a specific design of the associated pottery (Němejcová-Pavúková 1998). The Boleráz group was thought to occur later than the Proto-Boleráz group of Šturovo (Baden Ia) in Slovakia (Kalicz 1991).

In the Boleráz period, three phases were differentiated (Baden Ib–Ic–IIa). The Baden Classical period was subdivided into three groups: Červený-Hradok (Slovakia, Baden IIb), Ossarn I (Baden III), and Ossarn II (Baden IVa), named after a site in Lower Austria (Ruttkay 1995).

#### Parallel Cultures

In southeastern Europe, cultures with characteristics similar to those of the Baden Culture are found in Romania (Cernavoda III), Greece (Sitagroi IV and Vb), and Bulgaria (Ezeroi XIII–VII). At Tell Dipsis in *Ezero*, Bulgaria, 13 strata were identified, and the culture encompassing strata XIII–VII was synchronized with the Boleráz period by Němejcová-Pavúková (1981).

*Sitagroi*—also a tell settlement—is a key archaeological site in northern Greece. The archaeological layers of this site are associated with five cultural phases (Renfrew 1971, 1986; Alram-Stern 1996). Ceramics from phases IV and Vb show similarities to the pottery from the Baden Culture and the Late Baden Culture, respectively (Breunig 1987).

In Romania, the *Cernavoda* site is archaeologically classified into the chronological sequence Cernavoda I–III–II, where the individual Roman numerals correspond to different places at the Cernavoda location. The Cernavoda III period was estimated to be parallel to the Boleráz period (Morintz and Roman 1968; Roman 1999; Maran 1998; Němejcová-Pavúková 1999).

#### <sup>14</sup>C-Dating of the Baden Culture and Parallel Cultures

The Vienna Environmental Research Accelerator (VERA) laboratory is engaged in a larger interdisciplinary project, “Absolute Chronology for Early Civilisations in Austria and Central Europe using Accelerator Mass Spectrometry”. In the course of this project, the Baden Culture and its relation to the parallel cultures is investigated. Thirty-two samples from various sites of the Baden Culture, mainly bones but also charcoals, were selected according to archaeological evidence and <sup>14</sup>C dated by the accelerator mass spectrometry (AMS) method at VERA.

Bone samples were decalcified and gelatin was produced from the organic substance. For the pre-treatment of the samples an automatic collagen extraction apparatus similar to the one developed by Law and Hedges (1989) was used. Charcoal samples were treated manually by the standard ABA method. Further processing and measurement of the cleaned samples is described in Wild et al. (1998). Since then, we changed from mounting duplicates and triplicates (targets with identical target material) of all samples into our 40-position target wheel to the use of only two duplicates of the C-3 IAEA  $^{14}\text{C}$ -standard. The purpose of the multiple targets at different positions was to compensate for small position dependency problems, which turned out to originate from a slight eccentricity of the target wheel. We now use the two standard duplicates distributed at opposite positions around the wheel to monitor eccentricity effects. Small eccentricity effects can be corrected mathematically by using the measured  $^{14}\text{C}/^{12}\text{C}$  and the  $^{13}\text{C}/^{12}\text{C}$  ratio of the identical targets. Larger eccentricity effects require a retuning of the machine. During the measurement, data are automatically evaluated by a computer program, which allows an online check of various diagnostic marks. Details of this program are described in Puchegger et al. (2000). The  $^{14}\text{C}$  ages of the samples calculated according to Stuiver and Polach (1977) are converted to calibrated ages with the OxCal calibration program (Bronk Ramsey 2000).

With the  $^{14}\text{C}$  ages determined at VERA and the 43 ages found in the literature, a data set of 75 dates is now available for the Baden Culture period. Table 1 lists the complete data. From this data set, the data of the different phases in east-central Europe were grouped and analyzed by sum calibration with OxCal. With this option of the calibration program, the probability distributions of all events assigned to a single phase of a cultural period can be summed up, giving each event the same weight. The result is a new probability distribution that gives a best estimate of the chronological distribution of the dated events (Bronk Ramsey 1999). In other words, if the data set is sufficiently large, the 68% probability range of such a distribution means that 68% of the total events fall within this time interval. This implies that the 68% time interval of the sum calibration allows significant conclusions, whereas this is not possible for the 1- $\sigma$  interval of the calibration of single events.

Table 2 shows the 68% and 95% intervals of the sum calibration for the individual phases of the Baden culture. These results were compared with those of sum calibration performed for the south-eastern cultures displayed in Table 3.

## DISCUSSION

For interpretation of the results of the sum calibration, only the time periods corresponding to the 68% confidence level are considered. This seems to be a useful way to reduce the influence of outliers in a data set of the investigated cultural period. A few such samples in a data set of a cultural phase with ages much younger or older than the investigated period would cause a broadening of the 95% interval of the sum distribution, but would have little effect on the 68% time period. As described above, the 68% time period of the sum calibration allows a significant assessment of a cultural phase.

For the Proto-Boleráz, a 68% time period from 3630 to 3360 BC was determined. This period is nearly identical with the period determined for the Boleráz phase. Although an overlap exists between the Červený Hradok and the Boleráz time, the younger phases of the Baden-Classical period can be distinguished from the Boleráz by sum calibration.

Overlaps of the individual time intervals are found for the sequence Červený Hradok–Ossarn I–Ossarn II. This sequence cannot be resolved with the sum calibration of the  $^{14}\text{C}$  ages. The calibration curve shows a small plateau in this time period. We must also note that for the Červený Hradok and Ossarn II phases, only five samples were analyzed. A larger data set for these two phases would be more informative.

Table 1 Currently available data for the Baden and the parallel cultures. For more detailed information on these data, see Stadler et al. (2000).

Country	Site	Lab code	Material	<sup>14</sup> C age (BP)	1-σ error	Culture	Reference for the site
YU	Gomolova	GrN-13168	Charcoal	4380	70	Baden	Forenbaher 1993
H	Ószentiván	Bln-476	Charcoal	4515	80	Baden	Bojadžiev 1992
SK	Podolie	Bln-556	Charcoal	4455	80	Baden	Forenbaher 1993
H	Sümeg	A-246	— <sup>a</sup>	4520	60	Baden	Forenbaher 1993
H	Szigetcsép	Bln-1637	—	4350	45	Baden	Forenbaher 1993
A	Niederhollabrunn	ETH-15241	Bone, human	4710	95	Baden?	Laurmann 1996
RO	Cernavoda I	Bln-61	—	4385	100	Parallel culture	Breunig 1987
RO	Cernavoda I	Bln-61a	—	4505	100	Parallel culture	Breunig 1987
RO	Cernavoda I	Bln-62	—	4260	100	Parallel culture	Breunig 1987
RO	Cernavoda I	Bln-1061	—	4710	100	Parallel culture	Görsdorf 2000
BG	Ezero	Bln-421	Seed	4335	80	Parallel culture	Görsdorf 1996
BG	Ezero	Bln-422	Charcoal	4310	80	Parallel culture	Görsdorf 1996
BG	Ezero	Bln-427	Charcoal	4365	80	Parallel culture	Görsdorf 1996
BG	Ezero	Bln-428	Seed	4260	80	Parallel culture	Görsdorf 1996
BG	Ezero	Bln-429	Seed	4130	100	Parallel culture	Görsdorf 1996
BG	Ezero	Bln-1822	Charcoal	4275	65	Parallel culture	Görsdorf 1996
BG	Ezero	Bln-1824	Seed	4135	65	Parallel culture	Görsdorf 1996
GR	Sitagroi IV	Bln-773	Seed	4390	100	Parallel culture	Breunig 1987
GR	Sitagroi IV	Bln-782	Charcoal	4310	100	Parallel culture	Breunig 1987
GR	Sitagroi IV	Bln-878	Charcoal	4395	100	Parallel culture	Breunig 1987
GR	Sitagroi IV	Bln-879	Charcoal	4550	100	Parallel culture	Breunig 1987
GR	Sitagroi IV	Bln-880	Seed	4510	100	Parallel culture	Breunig 1987
GR	Sitagroi IV	BM 650a	Charcoal	4363	56	Parallel culture	Breunig 1987
GR	Sitagroi IV	BM 651	Seed	4332	79	Parallel culture	Breunig 1987
CH	Arbon Bleiche	B-6360	Charcoal	4710	30	Baden-Boleráz	Leuzinger 1999
CH	Arbon Bleiche	B-6361	Charcoal	4700	30	Baden-Boleráz	Leuzinger 1999
CH	Arbon Bleiche	B-6362	Charcoal	4640	30	Baden-Boleráz	Leuzinger 1999
CH	Arbon Bleiche	B-6363	Charcoal	4690	30	Baden-Boleráz	Leuzinger 1999
CH	Arbon Bleiche	B-6364	Charcoal	4620	40	Baden-Boleráz	Leuzinger 1999
CH	Arbon Bleiche	B-6365	Charcoal	4660	40	Baden-Boleráz	Leuzinger 1999
A	Baierdorf	VERA-838	Bone, animal	4645	35	Baden-Boleráz	Ruttkay 1998
A	Grub an der March	VERA-876	Bone, animal	4770	55	Baden-Boleráz	Krenn-Leeb 1991
A	Grub an der March	VERA-877	Bone, Animal	4760	50	Baden-Boleráz	Krenn-Leeb 1991
A	Grub an der March	VERA-878	Bone, animal	4790	55	Baden-Boleráz	Krenn-Leeb 1991
H	Gyöngyöshalász	Bln-2589	Charcoal	4790	50	Baden-Boleráz	Szabó 1983
CZ	Hlinsko	Bln-3232	—	4780	70	Baden-Boleráz	Pavelčík 1992
CZ	Hlinsko	Bln-3233	—	4680	60	Baden-Boleráz	Pavelčík 1992
CZ	Hlinsko	GrN-13149	—	4750	60	Baden-Boleráz	Pavelčík 1992
CZ	Hlinsko	GrN-16728	—	4650	40	Baden-Boleráz	Pavelčík 1992
CZ	Hlinsko	GrN-16729	—	4605	40	Baden-Boleráz	Pavelčík 1992
A	Schwechat	VERA-849	Bone, animal	4935	45	Baden-Boleráz	Ruttkay 1971
H	Szihalom	VERA-852	Bone, animal	4785	40	Baden-Boleráz	Szabó 1997
H	Szihalom	VERA-853	Bone, animal	4740	40	Baden-Boleráz	Szabó 1997
H	Szihalom	VERA-854	Bone, animal	4830	40	Baden-Boleráz	Szabó 1997
H	Szihalom	VERA-855	Bone, animal	4850	60	Baden-Boleráz	Szabó 1997
H	Szihalom	VERA-856	Bone, animal	4785	35	Baden-Boleráz	Szabó 1997
H	Szihalom	VERA-857	Bone, animal	4755	35	Baden-Boleráz	Szabó 1997
H	Szihalom	VERA-862	Charcoal	4735	35	Baden-Boleráz	Szabó 1997
H	Szihalom	VERA-863	Charcoal	4745	35	Baden-Boleráz	Szabó 1997
A	Zillingtal	VERA-860	Bone, animal	4625	35	Baden-Boleráz	Heiling-Schmoll 1985
A	Zillingtal	VERA-861	Bone, animal	4700	45	Baden-Boleráz	Heiling-Schmoll 1985

<sup>a</sup>Not available

Table 1 Currently available data for the Baden and the parallel cultures. More detailed information on these data is given in Stadler et al. (2000). (Continued)

Country	Site	Lab code	Material	<sup>14</sup> C age (BP)	1-σ error	Culture	Reference for the site
SK	Baje-Vlkanovo	VERA-736	Charcoal	4530	45	Classical Baden-Červený Hradok	Nevizánsky 1984
SK	Červený Hradok	GrN-11994	— <sup>a</sup>	4390	70	Classical Baden-Červený Hradok	Němejcová-Pavůvková 1985
A	Ossarn Stickleberger	GrN-6940	—	4520	40	Classical Baden-Červený Hradok	Mayer 1995b
A	Stillfried	VERA-850	Charcoal	4605	35	Classical Baden-Červený Hradok	Schappelwein 1994
A	Stillfried	VERA-851	Charcoal	4645	35	Classical Baden-Červený Hradok	Schappelwein 1994
CZ	Beladice	Bln-2171	—	4420	60	Baden-Ossarn I	Forenbaher 1993
PL	Iwanowice	Bln-352	—	4200	100	Baden-Ossarn I	Bogucki 1992
PL	Iwanowice	M-2166	Charcoal	4300	200	Baden-Ossarn I	Breunig 1987
H	Nagykanizsa	VERA-840	Bone, animal	4455	50	Baden-Ossarn I	Barna Judith 2000
H	Nagykanizsa	VERA-841	Bone, animal	4425	40	Baden-Ossarn I	Barna Judith 2000
H	Nagykanizsa	VERA-843	Bone, animal	4400	40	Baden-Ossarn I	Barna Judith 2000
H	Nagykanizsa	VERA-844	Bone, animal	4425	35	Baden-Ossarn I	Barna Judith 2000
H	Nagykanizsa	VERA-846	Bone, animal	4080	40	Baden-Ossarn I	Barna Judith 2000
A	Pottenbrunn	GrN-14016	Charcoal?	4560	40	Baden-Ossarn I	Mayer 1995a
SK	Šarišské Michalany	VERA-769	Charcoal	4385	35	Baden-Ossarn I	Šiška unpublished
A	Straß im Straßertale	VERA-893	Bone, animal	4515	45	Baden-Ossarn I	Wewerka 1995
SK	Svodín	Bln-2173	—	4460	60	Baden-Ossarn I	Forenbaher 1993
H	Vámosgyörk	VERA-903	Bone, human	4475	45	Baden-Ossarn I	Farkas unpublished
H	Vámosgyörk	VERA-904	Bone, human	4400	45	Baden-Ossarn I	Farkas unpublished
YU	Vučedol	Z-1446	Charcoal	4540	86	Baden-Ossarn I	Forenbaher 1993
YU	Vučedol	Z-1466	—	4540	130	Baden-Ossarn I	Ehrich 1992
YU	Vučedol	Z-1617	Charcoal	4500	100	Baden-Ossarn I	Bojadžiev 1992
YU	Vučedol	Z-1618	Charcoal	4300	100	Baden-Ossarn I	Bojadžiev 1992
YU	Vučedol	Z-1619	Charcoal	4400	100	Baden-Ossarn I	Bojadžiev 1992
YU	Vučedol	Z-1864	Bone	4626	100	Baden-Ossarn I	Forenbaher 1993
A	Franzhausen	VERA-868	Bone, human	4510	40	Baden-Ossarn-I	Neugebauer 1998
A	Girm	VERA-869	Bone, animal	4530	50	Baden-Ossarn-I	Böhm 2000
A	Girm	VERA-875	Bone, animal	4565	45	Baden-Ossarn-I	Böhm 2000
A	Hadersdorf	VERA-880	Bone, animal	4510	45	Baden-Ossarn-I	Wewerka unpub.
A	Hadersdorf	VERA-881	Bone, animal	4485	40	Baden-Ossarn-I	Wewerka unpub.
A	Lichtenwörth	Bln-2069	—	4540	45	Baden-Ossarn-II	Mayer 1995a
A	Lichtenwörth	Bln-2070	—	4530	70	Baden-Ossarn-II	Mayer 1995a
A	Lichtenwörth	Bln-2071	—	4410	60	Baden-Ossarn-II	Mayer 1995a
SK	Svodín	Bln-2169	—	4270	50	Baden-Ossarn-II	Bojadžiev 1992
SK	Svodín	Bln-2174	Charcoal	4390	60	Baden-Ossarn-II	Bojadžiev 1992
SK	Červený Hradok	GrN-11992	—	4820	70	Baden-Šturovo-Protoboleráz	Němejcová-Pavůvková 1984
SK	Červený Hradok	GrN-11993	—	4710	100	Baden-Šturovo-Protoboleráz	Němejcová-Pavůvková 1984
CZ	Hlinsko	Bln-1165	—	4670	80	Baden-Šturovo-Protoboleráz	Pavelčík 1992
CZ	Hlinsko	Bln-1166	—	4670	80	Baden-Šturovo-Protoboleráz	Pavelčík 1992
CZ	Hlinsko	Bln-1396	—	4775	60	Baden-Šturovo-Protoboleráz	Pavelčík 1992
CZ	Hlinsko	GrN-6941	—	4670	40	Baden-Šturovo-Protoboleráz	Pavelčík 1992
CZ	Hlinsko	GrN-6942	—	4670	45	Baden-Šturovo-Protoboleráz	Pavelčík 1992

<sup>a</sup>Not available

Table 2 Results of the sum calibration of the  $^{14}\text{C}$  ages of samples from the individual groups of the Baden Culture

Group name	Nr of samples	Baden Culture phase	68.2% – time interval of sum calibration	95.4% – time interval of sum calibration
Šturovo-Protoboleráz	7	Ia	3630 BC (14.1%) 3580 BC 3540 BC (54.1%) 3360 BC	3750 BC (94.3%) 3300 BC 3250 BC ( 1.1%) 3100 BC
Boleráz	27	Ib-Ic-IIa	3640 BC (46.0%) 3490 BC 3470 BC ( 4.2%) 3450 BC 3440 BC (17.9%) 3370 BC	3700 BC (95.4%) 3350 BC
Cervený Hradok	5	IIb	3510 BC (22.1%) 3430 BC 3380 BC (19.8%) 3300 BC 3240 BC (26.3%) 3100 BC	3550 BC (95.4%) 2900 BC
Ossam I	25	III	3350 BC (64.4%) 3010 BC 2980 BC ( 1.6%) 2960 BC 2950 BC ( 2.2%) 2930 BC	3500 BC (95.4%) 2500 BC
Ossam II	5	IVa	3350 BC ( 6.9%) 3310 BC 3240 BC (11.6%) 3170 BC 3160 BC (49.6%) 2870 BC	3400 BC (95.4%) 2700 BC

Table 3 Sum calibration for the southeastern parallel cultures

Group name	Nr of samples	Baden Culture phase	68.2% – time interval of sum calibration	95.4% – time interval of sum calibration
Ezero XIII-VII	7	I	3090 BC ( 2.1%) 3060 BC 3030 BC (41.8%) 2840 BC 2820 BC (24.3%) 2670 BC	3350 BC (95.4%) 2450 BC
Sitagroi	7	I	3330 BC (17.1%) 3220 BC 3180 BC ( 2.6%) 3150 BC 3120 BC (48.5%) 2880 BC	3550 BC (95.4%) 2650 BC
Cernavoda I	4	?	3550 BC (68.2%) 2850 BC	3700 BC (95.4%) 2600 BC

The time intervals determined by sum calibration for the southeastern parallel cultures indicate that the Ezero and the Sitagroi Cultures—formerly synchronized with the Boleráz period—should be paralleled with the phases of the Classical Baden Culture. The sum calibration of the data from the Cernavoda I Culture gives a relative large time span, which is coeval with the whole Baden period, i.e. the Baden Boleráz and the Baden Classic period.

## CONCLUSION

We can deduce the following about the chronological sequence of these cultures, based on the sum calibration results of the  $^{14}\text{C}$  data from the individual phases of the Baden culture.

1. The Boleráz period cannot be distinguished from the Proto-Boleráz period by the sum calibration of the available  $^{14}\text{C}$  dates. For the Šturovo-Proto-Boleráz the same time period was determined as for the Boleráz Culture. The younger phases of the Baden-Classical period (III and IVa) can be well distinguished from the Boleráz period.
2. The data from Cernavoda indicate that already the Cernavoda I period was coeval with the Baden culture. Previously, the Cernavoda III period was assumed to be contemporary with the Boleráz period, and according to archaeological evidence, the Cernavoda III period was later than Cernavoda I (Roman 1999). Thus, if the older Cernavoda I period is coeval with the Baden Culture, the subsequent Cernavoda III phase cannot be associated with the Boleráz time. It must

be noted that the Cernavoda I–III–II sequence may be verified in the future. The analysis of the Cernavoda I data is very tentative, because only four  $^{14}\text{C}$  dates (three of them determined in the 1960s) exist for this culture. For the Cernavoda II and III phases, no age determinations are available. Therefore, more  $^{14}\text{C}$  data are urgently needed for a better chronological assessment of the Cernavoda phases. New typological investigations reconfirm the connection between Boleráz and Cernavoda III (Němejcová-Pavůková 1999).

3. The two other cultures from southeast Europe, Ezero XIII–VII and Sitagroi IV, seem to be parallel to the Baden Classical culture.

The problem of synchronizing the Sitagroi phase IV with the Boleráz stage of the Baden Culture, and of synchronizing Sitagroi Va and b with the Classical Baden is described by Breunig (1987). The  $^{14}\text{C}$  data from both Sitagroi stages were too young for this synchronization, which was established by Němejcová-Pavůková (1981). Breunig also pointed out that difficulties arise in the synchronization of Cernavoda III and Ezero XIII–VII with the Boleráz phase when the  $^{14}\text{C}$  ages (only a few at this time) are considered.

According to these results it seems that—against former assumptions—the Baden Culture developed in central Europe and spread to the southeastern parts of Europe. The idea of a west–east spread of the Baden culture is also supported by the assumption of Maran (1998). However, before jumping to definite conclusions, more data for the southeastern groups are needed to verify our results. If this hypothesis is true, it would lead to a completely new view of the rate of cultural exchange along the Danube valley, and as another consequence, the theory that wheeled vehicles developed in the Middle East should be scrutinized.

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