

NEW EVIDENCES TO UNDERSTAND THE BELL BEAKER CULTURE IN THE MAŁOPOLSKA UPLAND

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The aim of the article is to present the new AMS ^{14}C dating and analysis of strontium, carbon and nitrogen isotopes acquired for graves 2 and 5 from Beradź, Sandomierz county. In both graves there were buried individuals at senilis age: in the grave 2 – a female and in the grave 5 – a male. The newly acquired dates indicate that graves from southeastern Poland could be synchronized with the older or classical stage of the Bell Beaker culture development within its eastern province restricted to the range of about 2400–2200 BC. Analysis of carbon and nitrogen isotopes allowed to state that the paleodiet of buried individuals was typical for terrestrial environments based on C3 plants supplemented with animal protein. Results of strontium isotopic signatures showed that a female was local, while a male spent his childhood somewhere else but probably within Małopolska Upland areas.

Keywords: Małopolska Upland, Bell Beaker culture, Final Neolithic, ^{14}C chronology, isotopic analyses.

Discovers of the Bell Beaker culture graves in southeastern Poland or more exactly in the Małopolska Upland are exceptional events. There have been known 10 sites with graves of this culture so far (Fig. 1; *Budziszewski/Włodarczak 2010*; *Rudnicki/Włodarczak 2010*). Some osteological materials from these sites have been currently under interdisciplinary, i. e. isotopic, genetic and chronometric analysis (*Linderholm et al. 2020*; *Olalde et al. 2018*; *Włodarczak/Kowalewska-Marszałek 1998*). As a part of the NCN project (2016/20/S/HS3/00307),

^{14}C dating and analysis of strontium ($^{87}\text{Sr}/^{86}\text{Sr}$), carbon ($\delta^{13}\text{C}$) and nitrogen ($\delta^{15}\text{N}$) isotopes for graves 2 and 5 from Beradź, Sandomierz county have been performed. These graves formed a small cemetery of three burials (Nos. 1, 2, 5) located at the edge of the loess plateau rising above the valley of the Kozinka River. The excavations were conducted in 1928 by K. Salewicz (*Żurowski 1932, 124*) and then they were described in terms of the funeral rite and equipment details by J. *Budziszewski and P. Włodarczak (2010)*.

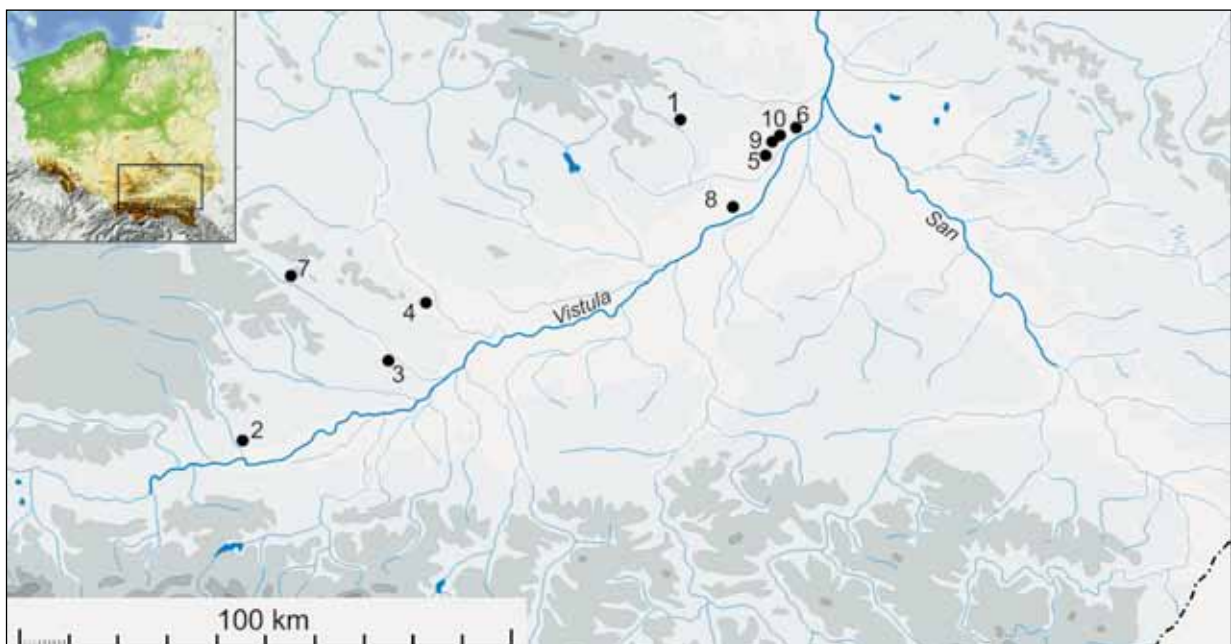


Fig. 1. Location of the Bell Beaker Culture grave sites in the Małopolska Upland. 1 – Beradź, site 1; 2 – Kraków-Krzyszów, site 41; 3 – Odonów, site 4 (unpublished); 4 – Pełczyska, site 6; 5 – Samborzec, site 1; 6 – Sandomierz, site 1 ('Wzgórze Zawichojskie'); 7 – Święcice, site 7; 8 – Świniary Stare, site 1; 9 – Złota, site 2 ('Grodzisko II'); 10 – Złota, site 3 ('Nad Wawrem').

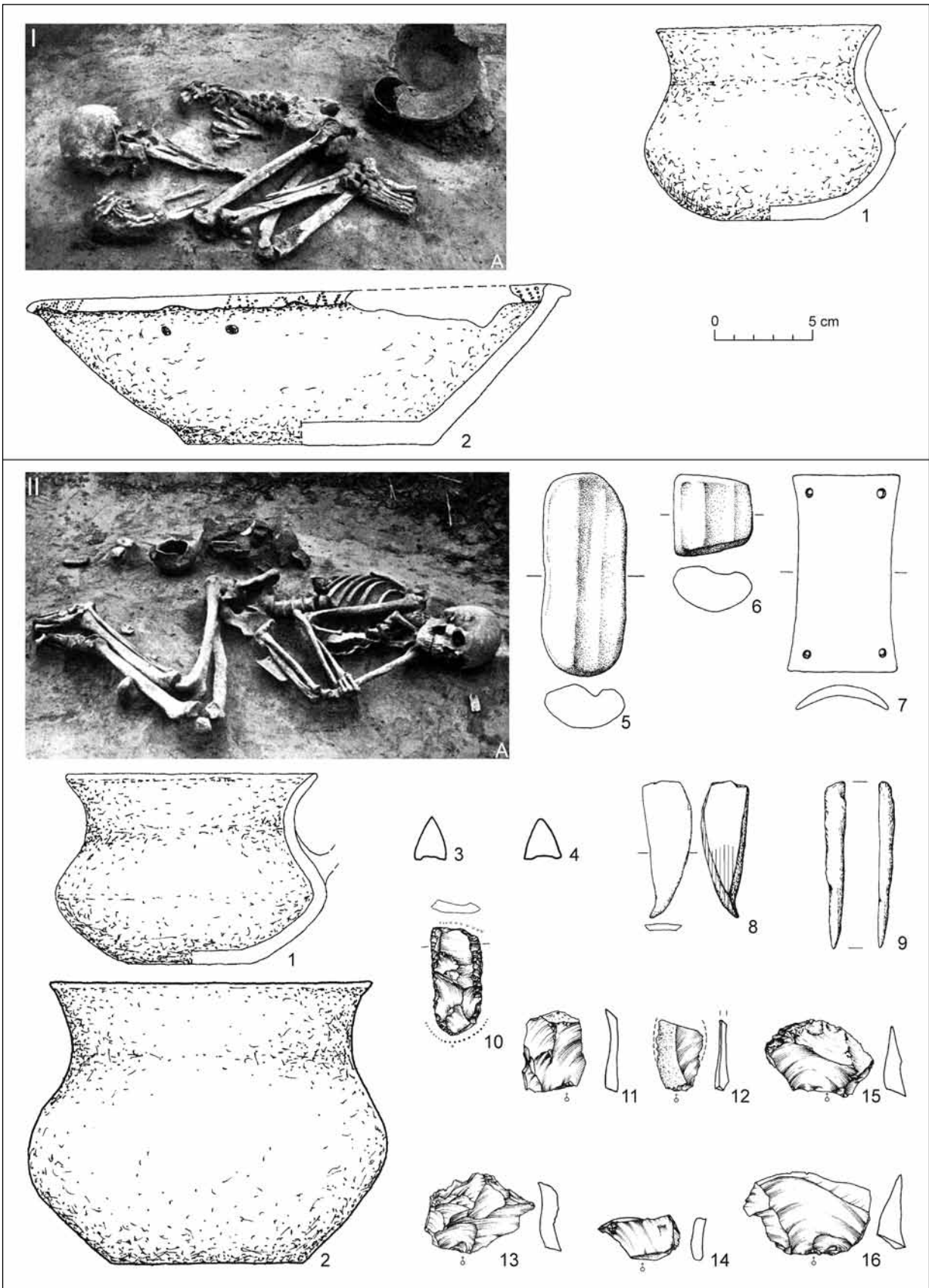


Fig. 2. Beradz, Sandomierz county, site 1. I – grave 2: A – photo of the grave; 1, 2 – grave inventory; II – grave 5: A – photo of the grave; 1–16 – grave inventory (after Budziszewski/Włodarczak 2010).

A female at *senilis* age was buried (Haduch 2010) in grave 2. She was placed on the right side with strongly bent legs and the head facing to the south. Grave goods were gathered at the height of the deceased's legs and consisted of a bowl and a cup with a damaged ear (Fig. 2: II1, II2). In grave 5 there was discovered a male at *senilis* age, placed in a contracted position on his left side with the head to the north. Most of the equipment was located behind the deceased at the hip level. These were two vessels (Fig. 2: II1, II2), a bone awl (Fig. 2: II9), a boar tool (Fig. 2: II8), two polishing stones, likely used for arrowheads (Fig. 2: II5, II6) and flint chips (Fig. 2: II11–II16). Two flint arrowheads were placed nearby (Fig. 2: II3, II4). The archery wristguard was located at the left forearm (Fig. 2: II7) and the flint striker (Fig. 2: II10) at forehead level.

Graves 2 and 5 from Beradź contained 4 vessels: a beaker (grave 5), cups with damaged ears (grave 2 and 5) and a bowl (grave 5), which was the only one to have a decoration on the thickened rim of the vessel. This type of decoration is relatively common at Moravian sites of Bell Beaker culture, e. g. at the cemetery in Blažovice, site II and Kobylnice, site I (Dvořák 1992, pl. 37: 39; 52: B4). In grave 5, archery equipment consisting of a stone archery wristguard (according to the classification of E. Sangmeister 1974), flint arrowheads and polishing stones was discovered. Such artefacts are usually found only in rich, male burials. In the eastern province of this culture, we know such assemblages (Ryan et al. 2018, fig. 1; tab. 1; 2). In the Małopolska Upland, separate elements of this equipment are known from the graves at Świnary Stare, grave 4/1; Złota 'Nad

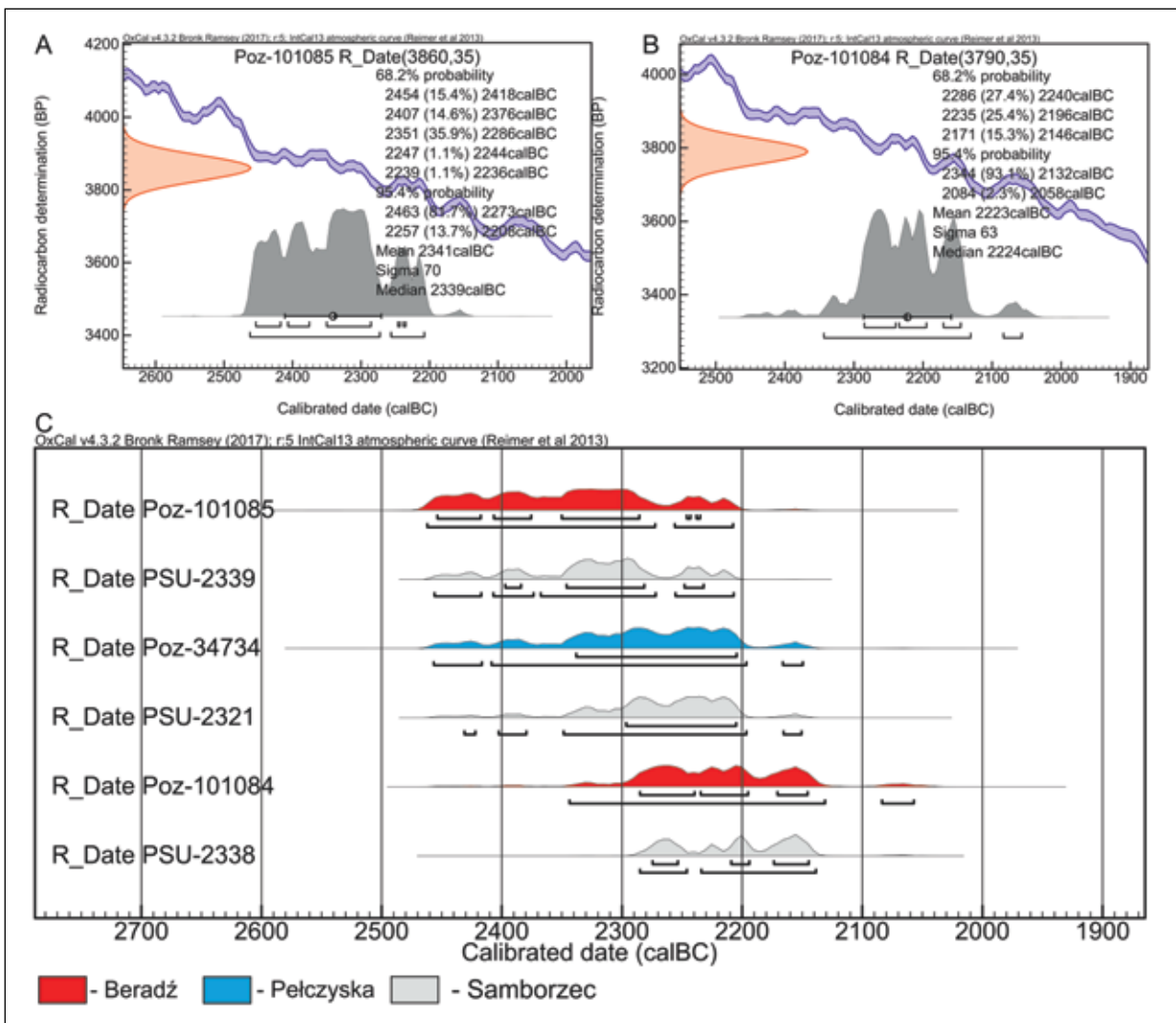


Fig. 3. Diagram with AMS dates calibration of the Bell Beaker culture from Beradź, site 1, grave 2 (A) and grave 5 (B). C – calibrated AMS dates from the Małopolska (after Rudnicki/Włodarczak 2010; Olalde et al. 2018).

Table 1. Results of isotopic analysis: ^{14}C , $^{87}\text{Sr}/^{86}\text{Sr}$, $\delta^{13}\text{C}$ and $\delta^{15}\text{N}$ (* – Rudnicki/Włodarczak 2010; ** – Olalde et al. 2018; *** – Linderholm et al. 2018).

Site	Feature/ grave	Lab. No.	BP	68,2 %	95,4 %	$\delta^{13}\text{C}_{\text{coll}}$	$\delta^{15}\text{N}_{\text{coll}}$	$^{87}\text{Sr}/^{86}\text{Sr}$
Beradź, site 1	2	Poz-101085	3860 ±35	2454–2236	2463–2273	–20	10.2	0.709665 ±10
Beradź, site 1	5	Poz-101084	3790 ±35	2286–2146	2344–2058	–20.1	10.6	0.708667 ±12
Pelczyska, site 6	12/2004	Poz-34734*	3830 ±35	2339–2205	2457–2417	–	–	0.709384 ±16***
Samborzec, site 1	1	PSUAMS-2338**	3780 ±20	2275–2145	2286–2139	–	–	–
Samborzec, site 1	7	PSUAMS-2321**	3825 ±25	2297–2206	2432–2151	–	–	–
Samborzec, site 1	13	PSUAMS-2339**	3850 ±20	2398–2233	2457–2208	–	–	–

Wawrem', grave 386b; Samborzec, graves III and X; Święcice, grave 5 and Złota 'Grodzisko II', grave 173 (all sites in Sandomierz county; Budziszewski/Włodarczak 2010). In grave 5, artefacts made of boar or pig canine and awl were also found. For grave 2 a date 3860 ±35 BP (Poz-101085) from a fragment of the long bone diaphysis was obtained that can be referenced after calibration to 2454–2236 BC (1 σ ; Fig. 3: A). A younger date was acquired for grave 5, that was 3790 ±35 BP (Poz-101084), i. e. after calibration 2286–2146 BC (1 σ ; Fig. 3: B). Dating was done from the rib of the deceased.

Older ^{14}C dates for graves of the Bell Beaker culture from the Małopolska Upland at sites in Samborzec and Sandomierz have been acquired using the conventional method in the radiocarbon laboratory in Kiev (cf. Budziszewski/Włodarczak 2010, 114, table 11). In recent years, radiocarbon signatures using the AMS method have also been obtained for selected graves from Samborzec and Pelczyska, Pińczów county (Table 1; Olalde et al. 2018; Rudnicki/Włodarczak 2010). Dating for Samborzec shows significant differences between two different laboratories – for example: grave 7: 3825 ±25 BP (PSUAMS-2321; Olalde et al. 2018) and 3990 ±60 BP (Ki-7926; Budziszewski/Włodarczak 2010, 114, table 11).

Signatures gained for two graves from Beradź fall within the AMS dating range acquired for graves from Samborzec and Pelczyska (Fig. 3: C). Moreover the sequence of dates enable to distinguish the compacted time horizon for these finds, situating them in the period of cultural transformations taking place in the Final Neolithic and the Early Bronze Age.

Modelling of dating in Oxcal program (Fig. 4; Bronk Ramsey 2017; Reimer et al. 2013) also indicates a fairly short period for inhabitation of the Bell Beaker communities in the Małopolska Upland, that with a probability of 95.4 % refers to the years 2416–2211, and with a probability of 68.2 % to the years 2331–2241 (Fig. 4). In the first case, it can be

synchronized with the end of the Corded Ware culture in the Małopolska Upland and the proto- and early phase of the Mierzanowice culture (Górski et al. 2013; Kadrow 1997; Kadrow/Machnik 1997). In the 68.2 % range, it corresponds with only early phases of the Mierzanowice culture. The coexistence of the Corded Ware culture and the Bell Beaker culture are indicated by individual ^{14}C dating (see Szczepanek et al. 2018, table 1; Włodarczak 2017, fig. 6; 2018, 195, table 7) and some cups from phase IIIb decorated with zone ornamentation in the Corded Ware culture assemblages according to P. Włodarczak (2006, 115, 116), i. e. Żuków, Sandomierz county, grave 3[4] (Jarosz/Włodarczak 2007). The new dates obtained for the Bell Beaker culture from the Małopolska Upland are consistent with those obtained for graves in Lower Silesia (Furmanek et al. 2015, 533–535).

Carbon ($\delta^{13}\text{C}$) and nitrogen ($\delta^{15}\text{N}$) stable isotope analyses were performed at the Isotope Dating and Environment Research Laboratory at the Institute of Geological Sciences of the Polish Academy of Sciences in Warsaw. Collagen for these analyses was earlier extracted for AMS ^{14}C dating in the Poznań Radiocarbon Laboratory. Stable isotope composition was determined using a Thermo Flash EA 1112HT elemental analyser connected to a Thermo Delta V Advantage isotope ratio mass spectrometer in a Continuous Flow system. Results of the stable carbon and nitrogen isotopes analyses are shown in Figure 5 (A) and are listed in Table 1. Individuals from Beradź were presented on the background of the Final Neolithic Corded Ware culture and the Mierzanowice culture individuals from south-eastern Poland (according to Werens et al. 2018a; 2018b; Jarosz/Szczepanek 2019; Linderholm et al. 2020). The human stable isotope values of individuals of the Corded Ware culture except some outliers vary within a narrow range: $\delta^{13}\text{C}$ between –20.4 and –19.3 ‰ and $\delta^{15}\text{N}$ from 10 to 12.2 ‰. Higher $\delta^{15}\text{N}$ signature (13.5 ‰ and 14.5 ‰) of two outliers are result of breastfeeding

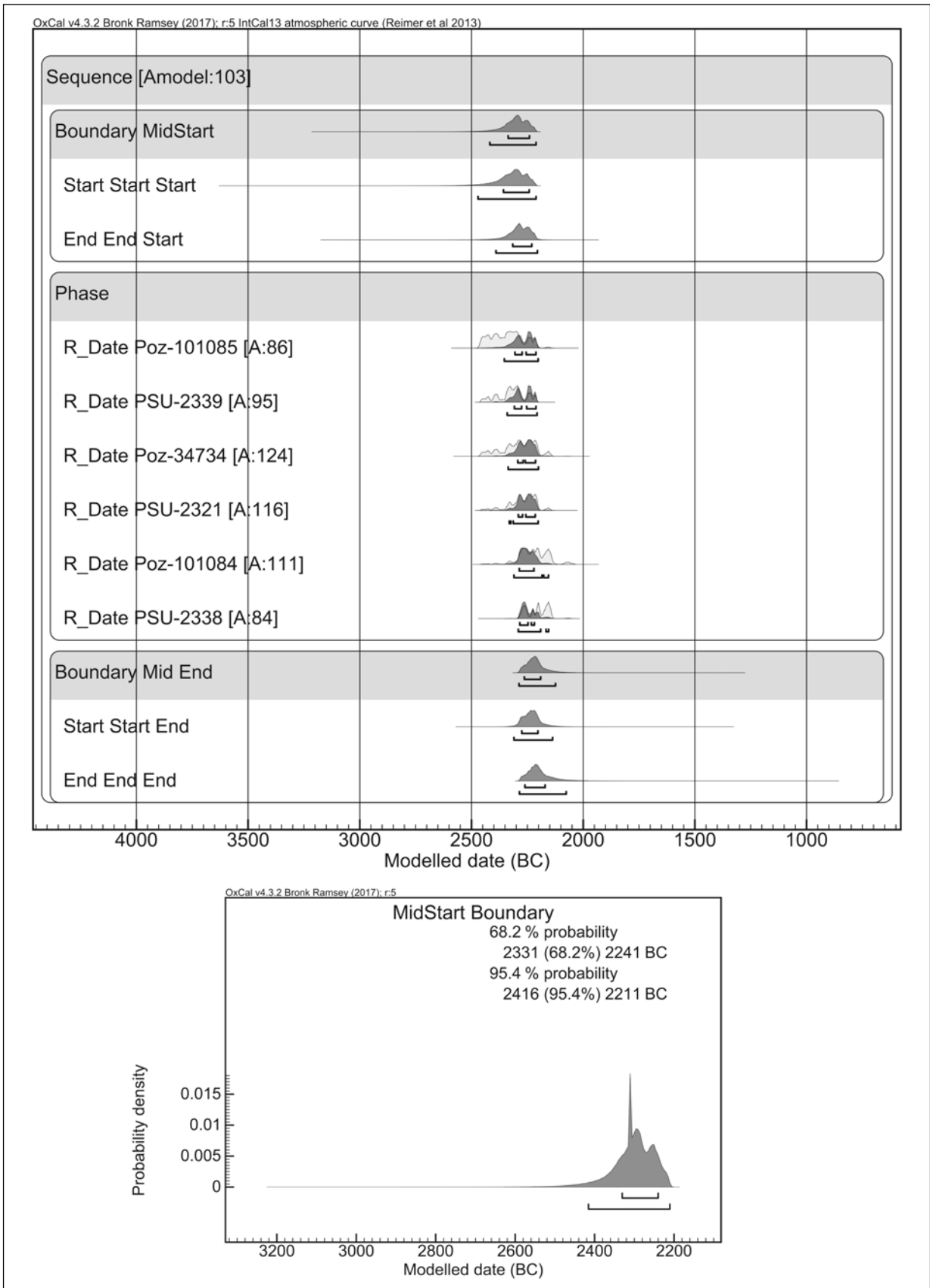


Fig. 4. Probability distribution of ¹⁴C data of the Bell Beaker culture from Małopolska Upland (Trapezium). Edited by P. Jarosz.

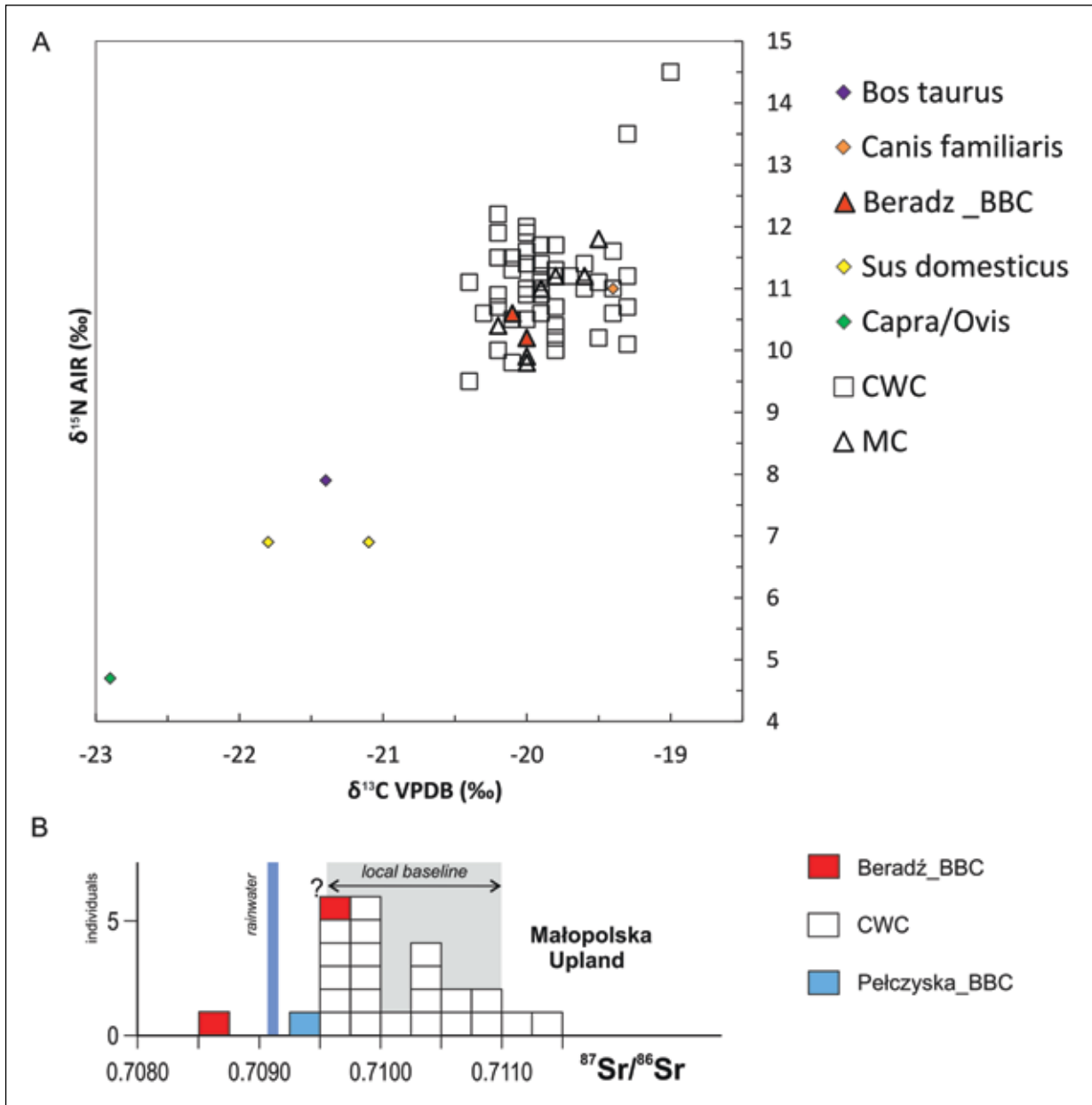


Fig. 5. Stable isotope results of $\delta^{13}\text{C}$ and $\delta^{15}\text{N}$ in human and faunal remains from the Corded Ware, the Bell Beaker and the Mierzanowice culture from Małopolska Upland (A) and strontium isotope ratios ($^{87}\text{Sr}/^{86}\text{Sr}$) in human tooth enamel from the Bell Beaker culture sites at Beradz, Sandomierz county and Pelczyska, Pińczów county on the background of results acquired for the Corded Ware culture communities in Małopolska Upland (B; after Linderholm 2020 *et al.*; edited by A. Szczepanek).

effect and lower nitrogen values (9.8 ‰ and 9.5 ‰) of two other outliers are probably an effect of their special diet possibly connected with their poor health condition (Szczepanek *et al.* 2018). The ranges for the Mierzanowice culture individuals are nearly similar ($\delta^{13}\text{C}$: -20.2 and -19.5 ‰; $\delta^{15}\text{N}$: 10.4 to 11.8 ‰) with visible two outliers ($\delta^{15}\text{N}$: 9.9 ‰ and 9.8 ‰). Result acquired for individuals from Beradz are generally placed within these ranges but $\delta^{15}\text{N}$ values (10.2 ‰

and 10.6 ‰) create the lower part of them (Fig. 5: A). Domestic animals from the same region demonstrate depleted levels of both $\delta^{13}\text{C}$ and $\delta^{15}\text{N}$ values. Acquired data are usual for humans living in a moderate climate with a terrestrial diet based on C3 plants, animal protein and possible riverine resources consumptions (Ambrose/Norr 1993; Mariotti *et al.* 1980).

The Sr isotope analyses were carried out in the Isotope Laboratory of the Adam Mickiewicz University

at Poznań, Poland in dynamic collection mode on a Finnigan MAT 261 mass spectrometer (according to the procedure of *Belka et al. 2018*). The results of the strontium isotope investigations are shown in Figure 6 (B) and listed in Table 1. The strontium isotope signatures 0.709665 and 0.708667 acquired for individuals from Beradz differ from each other. The higher value is placed in lower part of the local baseline range established for individuals of the Corded Ware culture and being defined between 0.7095 and 0.7110 (*Linderholm et al. 2020*) whereas the lower value falls slightly below this local spectrum and suggest non-local origin of male individual. However, the differentiation of the local geology in the Małopolska Upland where the Maastrichtian (Upper Cretaceous) carbonates with Sr signatures around 0.7078 (*McArthur et al. 2001*) are locally exposed from under the cover of Pleistocene glacial deposits enable to extend this local baseline. Therefore it can be assumed that these individuals may have spent their childhood in this region but not in the same place.

Acquired radiocarbon dating in AMS technology and analysis of carbon ($\delta^{13}\text{C}$) and nitrogen ($\delta^{15}\text{N}$) and strontium ($^{87}\text{Sr}/^{86}\text{Sr}$) isotopes are very important for studies of the Bell Beaker culture in south-eastern Poland. The obtained dates confirm the possibility of including graves from southeastern Poland to the older or classical stage of the Bell Beaker culture de-

velopment within its eastern province (*Budziszewski/Włodarczak 2010*). According to the AMS signatures for the Bell Beaker culture graves (Table 1; Fig. 3) and the absolute chronology of this culture finds throughout Europe (*Olalde et al. 2018*), the dating of graves in the southeastern Poland can be restricted to the range of about 2400–2200 BC that is consistent with earlier opinions of *M. Rudnicki* and *P. Włodarczak (2010)*. Synchronization of the acquired data with the chronometry of cultures at the turn of the Neolithic and Bronze Age in southeastern Poland enable for considerations that the beginnings of the Bell Beaker culture are equal to or slightly younger than the materials of the late phase of the Kraków-Sandomierz group of Corded Ware culture (*Szczepanek et al. 2018*) and at the same time are little older than cemeteries and settlements of the earliest Mierzanowice culture phase (*Górski et al. 2013; Jarosz/Szczepanek 2019; Kadrow/Machnik 1997, 26; Włodarczak 2017; 2018*).

Analysis of stable isotopes allowed for reconstruction that the paleodiet of buried individuals was typical for terrestrial environments based on C3 plants supplemented with animal protein. It was also possible to found that the female buried in grave 2 from Beradz was local, while the male from grave 5 spent his childhood in the area where carbonate rocks with less radiogenic strontium signatures are present that is potentially available in some Małopolska Upland areas.

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Nové poznatky ku kultúre zvoncovitých pohárov v Malopolskej vysočine

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SÚHRN

Rádiouhlíkové datovanie a analýzy izotopov stroncia (Sr^{87}/Sr^{86}), uhlíka (δC^{13}) a dusíka (δN^{15}) z hrobov 2 a 5 z Beradz v juhovýchodnom Poľsku (Sandomiersky okres) priniesli nové dôležité poznatky. Hodnoty izotopov uhlíka a dusíka ukazujú, že strava ženy (hrob 2) a muža (hrob 5) vo veku senilis bola typická pre suchozemské prostredie, jej základom bola rastlinná zložka (rastliny fotosyntézy C3), ktorá bola dopĺňovaná živočíšnymi bielkovinami. Hodnoty izotopov stroncia naznačujú miestny pôvod ženy pochovanej v hrobe 2, zatiaľ čo muž pochovaný v hrobe 5 strávil detstvo mimo lokality Beradz a jej okolia, pravdepodobne ale niekde v Malopolskej

vysočine. Na základe rádiouhlíkového datovania je oba hroby z juhovýchodného Poľska možné priradiť staršej alebo klasickej chronologickej fáze kultúry so zvoncovými pohármi a datovať ich do rozpätia rokov 2400–2200 pred n. l. Na základe týchto zistení je počiatky kultúry so zvoncovými pohármi v juhovýchodnom Poľsku možné synchronizovať alebo datovať o niečo neskôr ako materiály z neskorej fázy krakovsko-sandomierskej skupiny kultúry so šnúrovou keramikou a zároveň sú juhovýchodopolské materiály kultúry so zvoncovými pohármi o niečo staršie ako pohrebiská a sídliská zo súčasnej fázy mierzanovickej kultúry.

