PLISSN 0081-3834

SPRAWOZDANIA ARCHEOLOGICZNE

INSTYTUT ARCHEOLOGII I ETNOLOGII POLSKIEJ AKADEMII NAUK

KRAKÓW 2020

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Editor's Address
CENTRE FOR MOUNTAINS AND UPLANDS ARCHAEOLOGY, INSTITUTE OF ARCHAEOLOGY AND ETHNOLOGY, POLISH ACADEMY OF SCIENCES, 31-016 KRAKÓW, UL. SŁAWKOWSKA 17

Ministry of Science and Higher Education
Republic of Poland

Volume financed by the Ministry of Science and Higher Education from the founds for science popularization activities, Contract Nr 651/P-DUN/2019

PL ISSN 0081-3834
DOI: 10.23858/SA/72.2020.2

Printed by
PARTNER POLIGRAFIA Andrzej Kardasz, Grabówka, ul. Szosa Baranowicka 77, 15-523 Białystok

Edition: 300 pcs.

Sprawozdania Archeologiczne is regulary listed in the: SCOPUS, CEJSH, ERIH Plus

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Indexed in:
IBZ – International Bibliography of Periodical Literature
IBZ – CD-ROM

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SPRAWOZDANIA ARCHEOLOGICZNE 72/2, 2020
PL ISSN 0081-3834
DOI: 10.23858/SA/72.2020.2.2116

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THE CEMETERY OF THE GLOBULAR AMPHORA CULTURE COMMUNITY AT THE ZŁOTA-GAJOWIZNA SITE IN THE LIGHT OF RADIOCARBON ANALYSIS AND DENDROCHRONOLOGY

ABSTRACT

Witkowska B., Czebreszuk J., Gmińska-Nowak B., Goslar T., Szmyt M., Ważny T. 2020. The cemetery of the Globular Amphora culture community at the Złota-Gajowizna site in the light of radiocarbon analysis and dendrochronology. *Sprawozdania Archeologiczne* 72/2, 259-284.

This paper presents a new series of absolute age determinations from the Złota-Gajowizna site. These are the first chronometric data from the most important necropolis of the central group of the Globular Amphora culture. The obtained dendrochronological data, which are unique for the sites of the Late Neolithic in Poland, made it possible to specify the results of the calibration. A new interpretation of the arrangement of the cemetery has been proposed, which is the starting point for determining the GAC funeral rite in the Sandomierz Upland.

Keywords: Globular Amphora culture, Gajowizna cemetery, funeral rites, radiocarbon chronology, dendrochronology, modelled calibration

Received: 14.06.2020; Revised: 11.09.2020; Accepted: 12.09.2020

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Despite the fact that the Gajowizna site cemetery was discovered almost 100 years ago, the number of human graves and the abundance of accompanying animal deposits make it a unique find within the Polish (central) group of the Globular Amphora culture (hereinafter GAC). The reduction of analytical value due to loosing part of materials through course of storage has not affected the significance of the necropolis as an important point of reference for the researchers of not only the GAC, but also the Late Neolithic in the Vistula basin. This has made the lack of absolute age determinations for the discovered assemblages even more acute. Under two projects financed by the National Science Centre in recent years (FUGA 2014/12/S/HS3/00355 and BEETHOVEN 2014/15/G/HS3/04720), the first series of chronometric data has been obtained, which forms the basis for establishing the chronology of the GAC in the Sandomierz Upland. The most significant of those data are a number of radiocarbon age determinations. At the same time, the character of the site in question made it possible to carry out dendrochronological analyses, which are unique for the sites of the Late Neolithic in Poland. In order to fully present the context of the obtained results, the arrangement and functions of the features discovered in the cemetery have been reinterpreted, since the increase in knowledge of the GAC funeral rites has falsified the view presented in the original publication on the site (Krzak 1977).

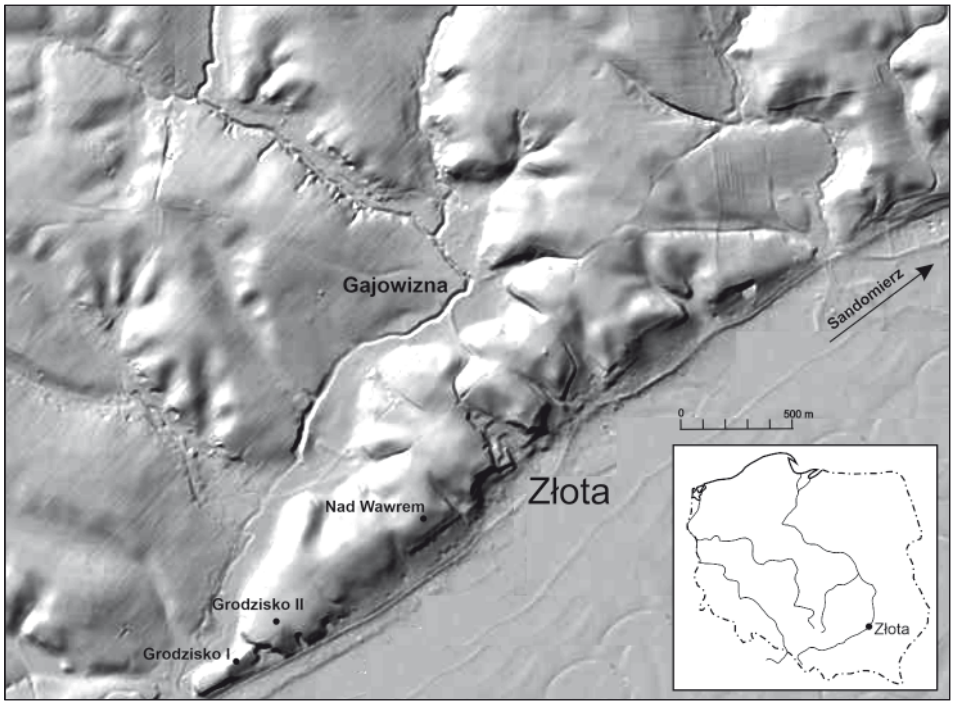

Fig. 1. The Gajowizna site. Location of GAC cemetery within the complex of the sites in Złota, Sandomierz district

The Gajowizna cemetery is usually said to be located in Złota. However, according to the documentation of the Archaeological Survey of Poland, it is situated in the fields outside Polanów Złocki (Fig. 1). It is marked as site 14 on Map Sheet 90-73 (AZP 90-73/14). Like the entire complex of sites in Złota, it was discovered by amateur explorer Zdzisław Lenartowicz, who spent almost 40 years searching for sites of archaeological significance, from 1882 until 1921, when his exploration was eventually discontinued due to a ban from the Office for the Protection of Historical Monuments (Krzak 1976, 8-14, *ibidem* further references; Witkowska 2013, table 2). It is difficult to determine the precise moment in Lenartowicz's activity when the Gajowizna site was dug, but some traces characteristic of his work, such as chaining pin holes, violated arrangements of skeletons or looted inventories, were recorded in 9 features unearthed during the 1926 field research. The complete GAC vessels, which have been included in the collections of several Polish museums since they were donated by Lenartowicz (Gągorowska-Chudobska 2015 and the unpublished collections of the State Archaeological Museum in Warsaw and the Archaeological Museum in Krakow), may be attributed to the necropolis in question, but there is no possibility of linking them with particular grave inventories.

The subsequent field research in Gajowizna was fully professional. It was carried out in 1926 by Zygmunt Szmit and Roman Jakimowicz on behalf of the State Group of Prehistoric Relicts Conservators. During the excavation of the site, a total of 35 archaeological features were discovered. Three years later, Jan Fitzke explored three more pits, including one "animal grave", but their nature and precise locations within the site remain unknown. The authors of the research immediately recognized the value of the discovered materials, which is evidenced by an article on "animal graves" (Jakimowiczowa 1927) published a year after the field works were completed. The Second World War and the difficult times that followed were not favourable for studying the collected material. The findings were not published until 50 years after the archaeological expedition (Kowalczyk ed. 1977). The authors of the publication, notably Zygmunt Krzak, who had undertaken the enormous effort of organizing and publishing the materials from the other Złota sites (*cf.* Krzak 1958; 1961; 1970; 1976; see also Podkowińska 1953; Rauhut 1953; 1962), were aware of the need to present the incomplete sources more exhaustively. Their publication is also the starting point for this article.

In the course of the aforementioned field works of 1926, a total of 32 GAC pits were discovered, out of which 30 were sepulchral features (Table 1). Such an accumulation of ritual structures makes Gajowizna the largest necropolis of the Polish GAC group. However, its analytical value had decreased due to the significant degradation of the site and the disappearance of some of the documentation and artefacts, including osteological materials. This was reflected in the source publication, which contains a number of discrepancies between the field documentation, the descriptions of the objects (Krzak 1977), and specialist zoological (Krysiak and Lasota-Moskalewska 1977; Lasota-Moskalewska 1977) and anthropological (Miszkiewicz 1977) analyses. The above discrepancies influenced the credibility of the archaeological interpretation proposed in the publication in question.

Table 1. The Gajowizna site. Characteristics of sepulchral features of the GAC

No	function	orientation	dimensions (cm)			number of buried person	stones	burnout	vessles	corded ornament	axes	other flints	bone tools	ornaments	shells	animal remains (number indicates individuals buried entirely)			remarks
			length	width	depth											cattle	pigs	goat / sheep	
1	human grave	W-E	460	250	100	3	x	*	4	x	1	-	-	1	x	x	x	x	bones of dog
2	human grave	NW-SE	200	160	25	5	x	-	2	x	1	4	1	1	x				-
3	animal deposit	W-E	230	120	75	-	-	-	-	-	-	-	-	-	-	-	8	-	bone of bear
4	animal deposit	W-E	240	135	80	-	-	*	-	-	-	-	-	-	-	4	-	x	-
6	human grave (?)	W-E	400	200	85	?	x	-	3	x	-	3	1	4		x	x	-	looted by Lenartowicz
8	animal deposit	NW-SE	197	123	45	-	x	-	-	-	-	-	-	-	-	1	-	-	-
9	human grave	NW-SE	240	135	45	2	x	-	4	-	-	3	-	x	x	-	x	-	-
10	human grave	NW-SE	200	90	45	3	x	-	4	-	2	2	-	-	-	-	-	-	-
13	human grave	NW-SE	245	110	50	1	x	*	2	x	-	1	-	-	-	x	x	x	looted by Lenartowicz
14	human grave	NW-SE	240	170	20	2	x	-	?	?	1	1		x	-	-	-	-	looted by Lenartowicz
15	human grave	NW-SE	250	110	-	≥1	x	-	x	x	-	-	-	-	-	x	-	-	lack of drawing documentation, looted by Lenartowicz
16	animal deposit	NW-SE	175	95	20	-	-	-	-	-	-	-	-	-	-	1	-	-	-
17	human grave	NW-SE	230	170	-	≥1	x	-	x	x	-	-	-	-	-	-	-	-	lack of drawing documentation, looted by Lenartowicz

18	human grave	NW-SE	340	130	-	2	?	-	?	?	-	-	-	x	-	-	-	-	lack of drawing documentation
19	animal deposit	NW-SE	180	105	25	-	x	-	-	-	-	-	-	-	-	2	-	-	-
20	human grave	NW-SE	240	130	15	≥1	-	-	2	-	-	-	-	-	-	-	-	-	lack of drawing documentation, looted by Lenartowicz
21	human grave	NW-SE	245	135	85	≥1	x	-	2	x	1	-	-	-	-	-	-	-	lack of drawing documentation, looted by Lenartowicz
22	animal deposit	NW-SE	195	130	95	-	x	-	-	-	-	-	-	-	-	2	-	-	-
23	human grave	NW-SE	220	200	45	≥1	x	*	3	-	1	-	-	-	-	-	-	-	-
24	human grave / animal deposit	NW-SE	480	165	60	2	x	-	4	x	-	-	-	-	-	10	2	3	bone of bear
25	animal deposit (?)	NW-SE	195	145	25	?	x	-	-	-	-	-	-	-	-	-	x	-	-
26	human grave	W-E	220	130	40	≥1	?	-	2	x	-	1?	-	x	-	-	-	-	lack of drawing documentation, looted by Lenartowicz
27	animal deposit (?)	W-E	470	170	35	-	x	-	-	-	-	-	1	-	-	4	2	x	-
28	human grave	N-S	240	180	65	2	x	*	-	-	1	1	-	-	-	x	x	-	bone of horse
29	animal deposit	N-S	385	175	60	-	x	-	-	-	-	-	1	-	-	4	-	-	-
30	human grave	N-S	290	170	65	1	x	*	3	-	1	-	-	x	-	x	x	-	
31	animal deposit	N-S	300	175	80	-	x	-	-	-	-	-	-	-	-	5	-	1	-
32	human grave	N-S	200	130	-	1	-	-	2	x	-	-	-	-	-	x	-	-	lack of drawing documentation, looted by Lenartowicz
33	animal deposit	N-S	150	120	12	-	-	-	-	-	-	-	-	-	-	-	-	-	lack of drawing documentation
34	human grave (?)	W-E	240	150	70	≥1	x	-	x	-	-	x	-	-	-	-	-	-	lack of drawing documentation
summary						≥ 30	22	6	≥ 40	-	9	≥ 17	4	≥ 12	-	28	12	7	-

Fig. 2. The Gajowizna site. The arrangement of cemetery according to the interpretation of Zygmunt Krzak (after Krzak 1977, with changes)

Z. Krzak grouped the discovered features into eight complexes, in each of which the so-called sacrificial pits, whose number varied from one to four, were located next to a human burial (Fig. 2; Krzak 1977, 64-67). However, in only three out of the eight clusters he distinguished (marked I, V and VII) was the arrangement of elements regular, which may reflect a repetitive sequence of the funerary rite. The hypothesis proposed by the scholar was based on poor premises, because the nature of almost a third of the discovered pits was not determined (Krzak 1977, 78-79), despite some evidence making it possible to establish their function with considerable likelihood. Only 11 features were classified as human graves. Moreover, two of them (11a and 12) were dated to a younger period, most probably the early Bronze Age. The omission of some data and the incorporation of differently oriented features into individual clusters gave the impression of a chaotic arrangement of the necropolis. It also precluded the recreation of the ritual and the demarcation of the possible phases of the cemetery's use.

A careful study of the site plan and the assumption of some research premises has allowed us to propose an interpretation, different from that of the aforementioned author, of the functions of some of the features and the spatial arrangement of the necropolis. It seems that the number of human graves was significantly underestimated in the original publication, which gave the impression that the people buried in the few sacrificial pits had enjoyed an exceptionally high status. However, some evidence allows for the identification of additional human graves within the structures discovered on the Gajowizna site. The following have been considered identification criteria for such features: the rectangular shape of the pit, notes about the discovery of skeletons or separate human bones included in the field documentation of the looted features, the presence of entire artefacts or pieces of vessels and/or flint items and/or decorations, and the absence of complete animal skeletons. It was important that at least three of the above criteria should be met and that the last of them be mandatory, because none of the characteristics is a good classification tool on its own.

The adoption of the first criterion, which refers to the shape of the feature, eliminated the settlement pits (features 5, 7 and 11, the first two of which might have been settlement pits of the GAC) from further analysis. Human bones were discovered in a total of 19 features, out of which 18 met the additional criteria to be considered as regular burials, including the postulated presence of only incomplete animal remains for symbolic consumption. An exception is Feature 24, which requires a more detailed analysis.

In that rectangular, W-E oriented pit, 4.8 m in length, 1.65 m in width and 0.6 m deep, probably 15 animals were deposited, including 10 cows, at least two pigs and three sheep or goats (Fig. 3). Among the animal carcasses, a child of the age of *Infans II* (Miszkiewicz 1977, 149) and four vessels (Krzak 1977, 40-42 and fig. 57) were deposited. Such a combination of animal deposits, a human burial and a set of vessels is an exception at the Gajowizna site. The following basic questions demand answering: What was the status of the burial of the child in reference to the animal deposits? Was the set of vessels dedicated to

Fig. 3. The Gajowizna site. Feature 24, with radiocarbon date and inventory (after Krzak 1977, with changes; artefacts illustrated by B. Witkowska)

the child or was it connected with the animals? Finally, was this a human grave or a sacrificial pit? It is difficult to answer the above questions without referring to other GAC sites where a similar configuration of deposits was recorded. Therefore, with respect to the presence of the same categories of finds (human remains, whole animal skeletons and ceramic artefacts), the closest analogy is site 4 at Brześć Kujawski in Kuyavia. Following K. Jażdżewski, who was in charge of the excavation, T. Wiślański arbitrarily divided the feature into two "animal graves": no. 1, including the skeletons of a female cow, pigs and a child, as well as vessels, and no. 5, including two bull skeletons, bones of a dog and two bone discs. In fact, it was one approximately rectangular (5.3 m × 1.5-1.6 m), W-E oriented pit, where the three complete cattle (the female in the eastern part and the two males in an antipodal position approximately 3 metres farther west) and parts of the carcasses of the two pigs and the dog were deposited. The remains of the pigs and the body of a 1.5-year-old child (*Infans I*) rested under the pelvis of the cow. Next to the rump of the cow, there was a vessel, and two ornamented bone discs were discovered around the heads of the bulls (Wiślański 1966, 203 and figs 41 and 42). The described feature was classified as an animal grave, and the burial of the child was considered to be of a sacrificial nature (Wiślański 1969, 297). The key marker of the sacrificial role of the child was the location of its remains under the carcass of the cow. A four- or five-year-old child buried between two cows, discovered in Dölkau, Germany, was interpreted in a similar manner. There, the animal and human remains were accompanied by vessels and a spindle-shaped blade made of bone (Behrens 1964). The hypothesis was related to the wider conception by T. Wiślański, who believed that the burials of children were considered less significant, reflecting their position within the community (1969, 309). Adopting this view, Feature 24 in Gajowizna should be classified as a sacrificial pit. However, no other animal deposit in the necropolis included ceramic inventory, even though features containing only animal skeletons deposited along with vessels have been found in all three territorial groups of the GAC. Such deposits have been found, *e.g.*, in Klementowice, site 7, on the Nałęczów Plateau (Uzarowiczowa 1975, 193), Koszyce, site 3, in Lesser Poland (Przybyła *et al.* 2013) and in Adolfin, Opatowice, site 1, Pikutkowo, site 5B and Strzelce, site 2, in Kuyavia (Wiślański 1966; Kośko *et al.* 2007), as well as in Stobra and Zauschwitz, Germany (Behrens 1964), Dolheştii Mari, Romania (Dinu 1960) and Krasnasielski, site 1, Belarus (Charniauski 1996). The last of the above features is particularly similar to Feature 24 in Gajowizna, with one exception, however: no human remains were found among the 13 deposited animals, most of which were cattle, accompanied by four vessels, spindle-shaped bone blades and an amber artefact.

The analogies cited above do not resolve the doubts concerning the function of Feature 24. As compared with the other features unearthed in Gajowizna, the content of the pit is unique, which may suggest that the deposited artefacts were dedicated to the buried child. In this cemetery, the presence of ceramic material is strictly connected with the deposition of human remains. The above argumentation justifies considering Feature 24 a human grave, subject to the aforementioned doubts.

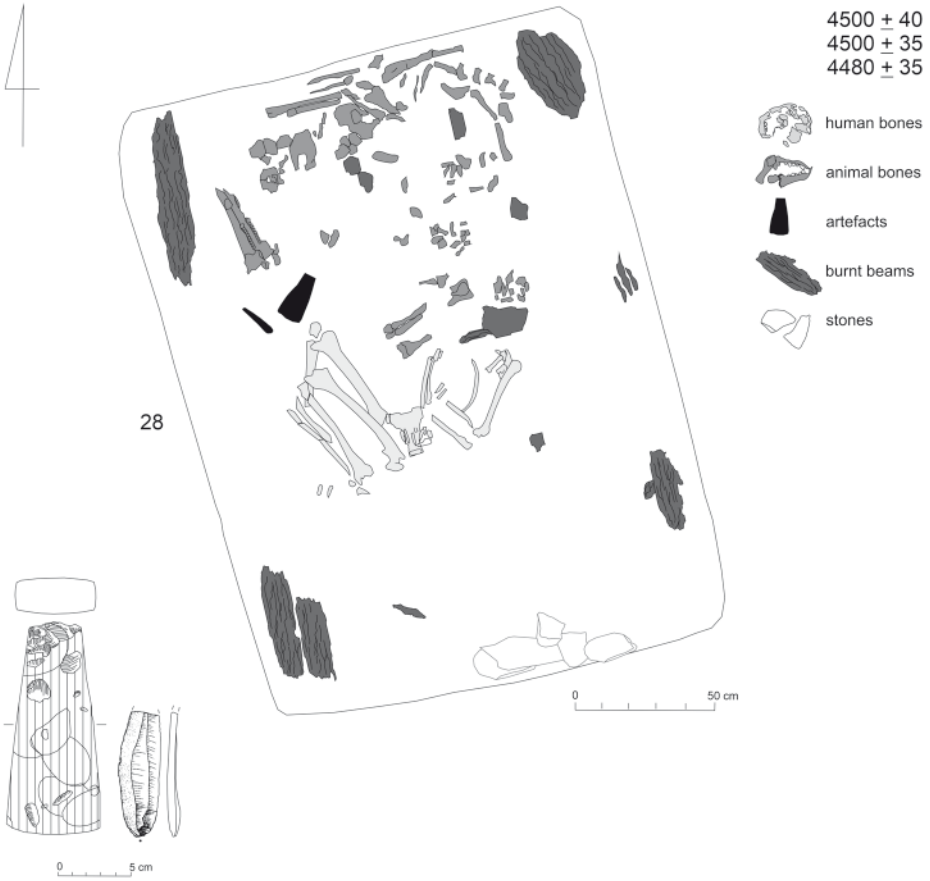

Fig. 4. The Gajowizna site. Feature 28 with radiocarbon date and inventory (after Krzak 1977, with changes, artefacts illustrated by B. Witkowska)

Undoubtedly, a good identifier of a human grave in the discussed cemetery is the presence of a flint axe in the feature. There were a number of such artefacts in Gajowizna. They were found in eight out of nineteen pits containing human remains (Table 1), which all were proper graves that originally included vessels, other flint or bone inventory and incomplete animal skeletons. The specimens of flint axes from Gajowizna, which are curated in museum collections, differ from other GAC tools in that they were relatively small (from 5.6 to 14 cm of length) and utilized massive flakes as blanks. Some of them were cracked due to overheating. Feature 1, in which an artefact of approximately 20 centimetres was discovered (now missing), and Grave 28, which included a 16-centimetre-long axe (Fig. 4; Krzak 1977, 47, fig. 62), are exceptions. Flint blanks and small tools made of them, such as retouched blades and flakes (most of which are missing), were discovered in the

Fig. 5. The Gajowizna site. Feature 6 with radiocarbon date and inventory (after Krzak 1977, with changes)

features that meet the other criteria for human graves. There were only a few bone or amber ornaments and they have been found in the same context.

As a matter of fact, only one type of artefact was found in both the pits containing complete animal skeletons and the hypothetical human graves: GAC-specific spindle-shaped bone blades were found in four features at Gajowizna (Table 1; Figs 5 and 6). Therefore, they were not determinants of any particular type of feature, although the results of functional analyses suggest a clear practical differentiation of tools, depending on the context of the find. The traseology studies of items from six GAC sites, carried out by Małgorzata Winiarska-Kabacińska, PhD, from the Archeological Museum in Poznań, was financed under NSC project no. 2014/12/S/HS3/00355, and its results will be published in a separate article.

Under the above assumptions, 18 human graves (*e.g.* Figs 4 and 5) and 12 accompanying animal deposits (*e.g.* Figs 6-8) can be identified at the Gajowizna site (Table 1; for different estimations, *cf.* Krzak 1977, 78-79; Przybyła and Włodarczak 2013, table 8). Most of the human graves included in Table 1 remained unidentified in the original publication; Krzak considered them pits of an undetermined nature (15, 17, 18, 20-21, 26, 34). Three other features (6, 23 and 28), which in 1977 were described as sacrificial pits (Krzak 1977, 78-79), may be classified as human graves based on the presence of human bones, pieces of vessels,

Fig. 6. The Gajowizna site. Feature 27 with radiocarbon date and inventory (after Krzak 1977, with changes)

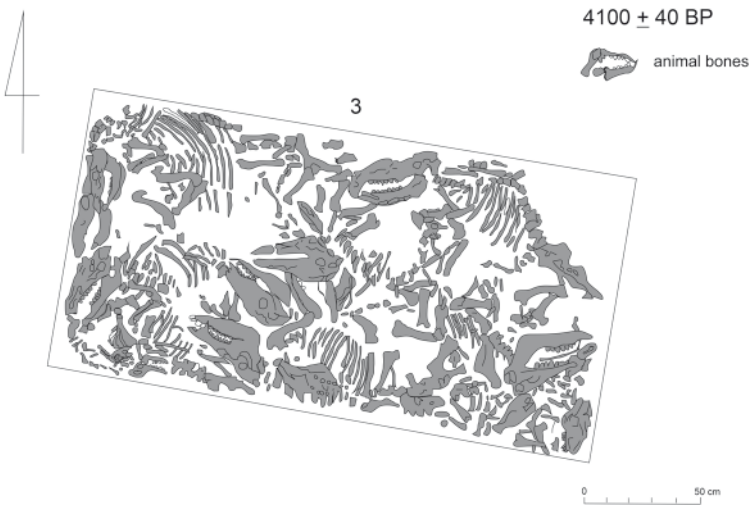

Fig. 7. The Gajowizna site. Feature 3 with radiocarbon date (after Krzak 1977, with changes)

flint objects, ornaments and animal half-carcasses. Feature 19, on the other hand, is likely to be an animal deposit and not a hypothetical human grave (Krzak 1977, 78-79) in light of a zoological analysis, whose results suggest that the complete skeletons of two cattle were deposited in the pit (Krysiak and Lasota-Moskalewska 1977, 86). In GAC human graves, the animal skeletons that have been found are primarily incomplete, and were possibly a symbolic meal for the deceased (Szmyt 2006; Kołodziej 2011).

The reinterpretation of the functions of particular features has allowed for the identification of some regularities in the arrangement of the Gajowizna necropolis (Fig. 9). The sacrificial pits containing complete animal specimens were located to the north-west or west of the human graves, and along the same axis. One burial chamber was usually accompanied by one animal deposit, although in complexes 4-3-1-6 and 14-25-24 there were two sacrificial pits, which was probably connected with the larger number of human graves. An important observation is that the double deposits contained different species of animals: the one closer to the burial chamber consisted of pig skeletons, while the one farther away – complete skeletons of cattle.

Thus, the repetitive sequences of actions which were discovered in the Gajowizna cemetery suggest a burial ritual in which human graves were accompanied by animal deposits. This pattern has been discovered in other GAC cemeteries, both in the Sandomierz Upland, *e.g.*, on site 1 in Malice (Witkowska *et al.* in print), and elsewhere, *e.g.*, in Kuyavian cemeteries in Pikutkowo and Zdrojówka (Wiślański 1966). A similar situation was recorded in Zauschwitz, Germany (Bergemann 2018, fig. 179). The above analogies, as well as the observations made so far, support the hypothesis regarding the existence of additional

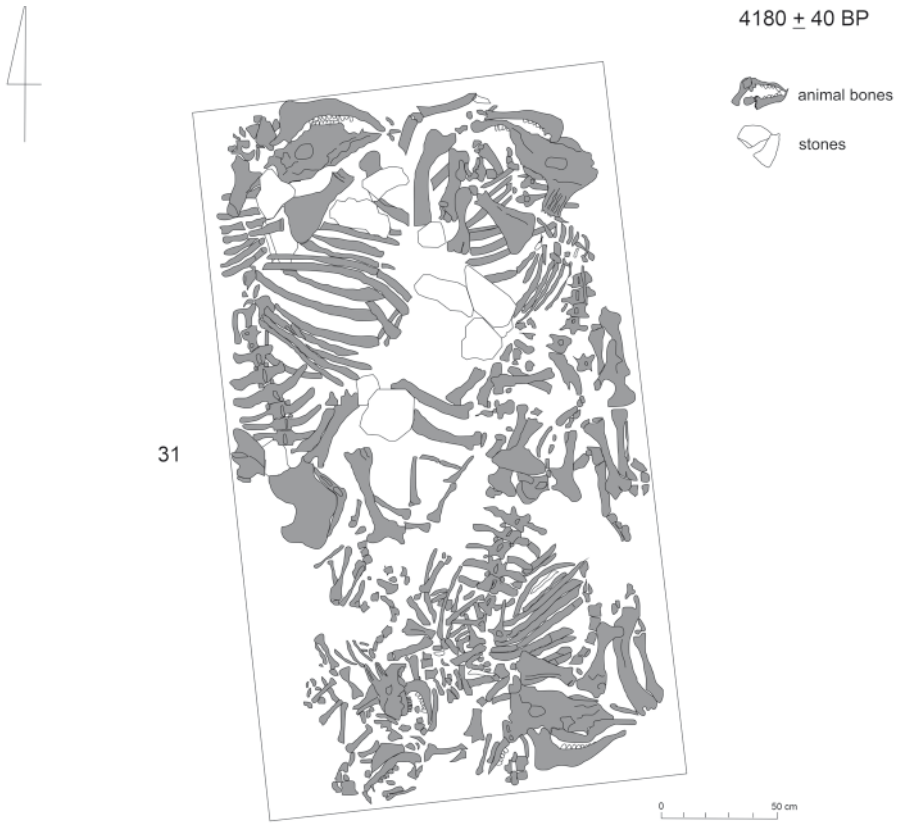

Fig. 8. The Gajowizna site. Feature 31 with radiocarbon date (after Krzak 1977, with changes)

animal deposits that were not unearthed during the excavation in the Gajowizna cemetery. They should accompany human graves marked 2, 10, 13, 15, 18, 21 and possibly 34 (Fig. 9). This observation is in line with the suggestion by the explorers of the site, who also propounded the possibility of further findings (Jakimowiczowa 1927, 33).

The new view on the spatial arrangement of the Gajowizna cemetery allows for the consideration of the duration of its use and possible division into phases, which would be reflected in two different orientations of sepulchral complexes: along W-E (complexes 4-3-1-6; 26-27 and 34) and NW-SE (complexes 8-9; 16-17; 19-20-21; 22-23; 14-24-25; 28-29-30-31 and 32-33) axes. It should be noted, however, that the artefacts found in those two complexes do not demonstrate taxonomic differentiation. Although the inventories of some features stylistically alluded to an older GAC development phase due to the absence of cord ornamentation, they co-existed within the said complexes with features containing ceramic wares decorated with this technique (*e.g.* complex 20-19-21). Assuming a relatively

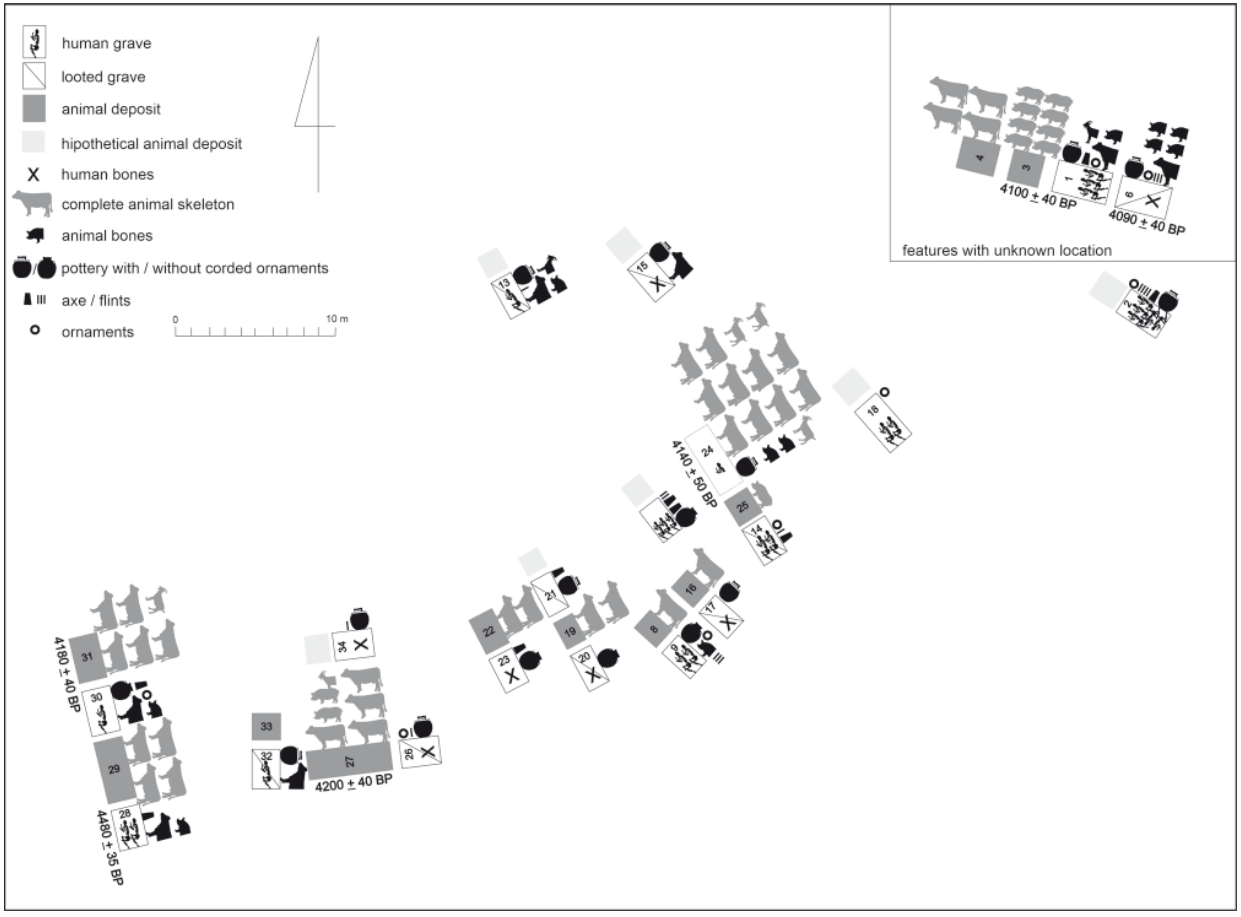

Fig. 9. The Gajowizna site. The reinterpretation of the cemetery arrangement based on the information from the field documentation in the source publication

short period of duration of the cemetery, most objects found therein probably date back to the IIIa phase of the GAC, although some burials may be older. Unfortunately, it is impossible to rule out the possibility that its contemporary presentation is a result of the fact that some artefacts have gone missing. As a result, any typological analyses and their conclusions regarding the Gajowizna necropolis must be treated with (a large dose of) caution and an awareness that the data is incomplete due to the extent of the site's damage and the later history of the sources.

Similar obstacles were faced during the selection of objects for radiocarbon dating. NSC project no. 2014/12/S/HS3/00355 involved running a series of radiocarbon analyses, which, as the first absolute date determinations for the Gajowizna necropolis, provide the possibility of establishing its absolute chronology, and allow us to distinguish a possible chronological sequence for certain sepulchral complexes. It has been assumed that obtaining dates from the pits that contained artefacts without cord ornamentation would be particularly valuable. However, the choice of actual objects for dating has been governed primarily by the availability of material. Most animal bones and charcoal from the discussed site have gone missing, while the human remains, which are now stored in the Department of Anthropology of the Institute of Immunology and Experimental Therapy in the Polish Academy of Sciences in Wroclaw, have been withdrawn from scientific circulation. As a consequence, the absolute chronology of the cemetery has been determined based on samples extracted from separate bones, which were found among the artefacts. Due to the above, it would be impossible to retest the samples should the results of laboratory tests be incongruent with the archaeological classification of the features or should an insufficient amount of collagen be obtained.

Eventually, ten absolute dates were obtained from the Gajowizna site (Table 2, Fig. 10). AMS radiocarbon tests were carried out in the Poznań Radiocarbon Laboratory mainly on osteological material. An exception is Grave 28, from which charcoal samples were sent for dating.

As expected, most of the results indicate the late Neolithic, but two human bones from Features 1 and 9 yielded results incongruent with the classification of the features made by means of taxonomic analyses. Regarding Sample Poz-90799 from grave 1, it is significant that the large amount of collagen (14%) correlates with a later radiocarbon date (1880±40 BP, *i.e.* 53-236 AD), which most probably means that the materials were jumbled in the course of the almost 100-year-long storage of the collection. The dating results from Grave 9 of the same cemetery can be explained in a similar manner. Even though, in the case of Grave 9, the absolute date measurement is not as distant from what was expected (3510±40 BP, 1941-1700 BC), it is difficult to accept it as correct, taking into account the fact that the feature undoubtedly belongs to the GAC. The adoption of such a broad timeframe for the Sandomierz Upland GAC contradicts the current state of knowledge on the demise of this culture, since the latest dates ascribed to it, which come from features of the eastern and central groups, oscillate around 2450-2300 BC (Kadrow and Szmyt 1996; Kośko and Szmyt

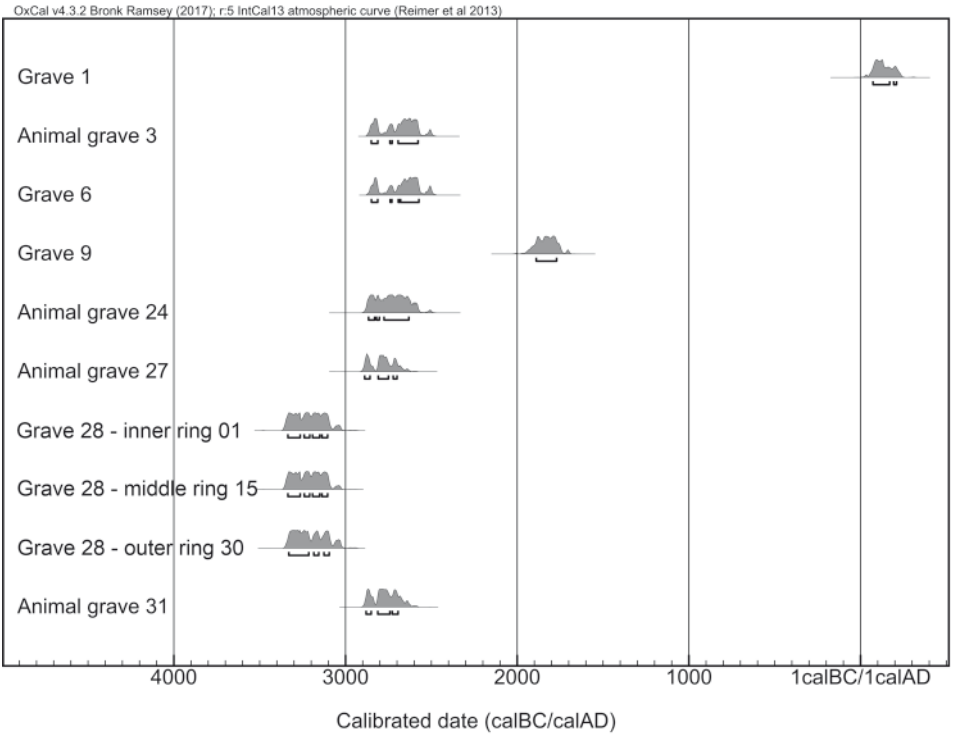

Fig. 10. The Gajowizna site. The calibration of the whole series of radiocarbon dates

2007, table 25.4). The dated bone most probably did not come from Feature 9. In the south-eastern part of the cemetery, there is a cluster of Features 11 and 12, which very likely date back to the early Bronze Age, which is supported by the inventory of Feature 11a (Krzak 1977, fig. 34). The presence of the Mierzanowice culture is further evidenced by an arrowhead found on the surface of the site (Krzak 1977, fig. 83). It is possible that the bone used as sample Poz-90803 actually comes from one of the aforementioned features of that culture.

The other results obtained within the test series are in line with the conclusions drawn based on traditional taxonomy (Table 2). Most absolute date determinations fall into the period from 4200±40 BP to 4090±40 BP, *i.e.*, 2889-2573 BC (1σ) or 2900-2493 BC (2σ). The broad timeframes of the calibrations of those dates are the consequence of an extensive flattening of the calibration curve (IntCal13: Northern Hemisphere, Reimer *et al.* 2013), which spans the first half of the 3rd millennium BC, *i.e.*, the time of the expansion of the GAC in the Sandomierz Upland.

The discussed site remains the largest cemetery of the Polish GAC group discovered so far. Yet, it is impossible to accept the thesis on such a long period of its utilization, spanning

Table 2. The Gajowizna site. Radiocarbon dating of samples from sepulchral features of the GAC

Object	Sample raw	No lab.	Age 14C BP	Date BC (68,2 %)	Date BC (95,4 %)	Modelled Date BC (68,2 %)	Modelled Date BC (95,4 %)
ZG-1	human bone	Poz-90799	1880 ± 40	73-210 AD	53-236 AD	-	-
ZG-3	animal bone	Poz-90800	4100 ± 40	2851-2578	2871-2497	-	-
ZG-6	animal bone	Poz-90802	4090 ± 40	2850-2573	2866-2493	-	-
ZG-9	human bone	Poz-90803	3510 ± 40	1890-1771	1941-1700	-	-
ZG-24	animal bone	Poz-90804	4140 ± 50	2867-2632	2878-2581	-	-
ZG-27	animal bone	Poz-90806	4200 ± 40	2889-2701	2900-2693	-	-
ZG-28 p01	charcoal (inner ring)	Poz-117272	4500 ± 40	3336-3105	3356-3033	3347-3122	3350-3119
ZG-28 p15	charcoal (middle ring)	Poz-117273	4500 + 35	3336-3105	3355-3091	3333-3106	3336-3105
ZG-28 p30	charcoal (outer ring)	Poz-117274	4480 ± 35	3331-3096	3342-3029	3318-3093	3321-3090
ZG-31	animal bone	Poz-90807	4180 ± 40	2881 - 2695	2891 - 2631	-	-

300-400 years, due to the relatively low number of funeral complexes found there. They probably evidence a simultaneous deposition or a sequence of interrelated ritual activities (*cf.* Szczodrowski 2012) executed in short intervals, which resulted in the common axis of the graves and the animal deposits dedicated to them. The consistent arrangement of the features and the absence of vertical stratigraphy provide further evidence of the short time spans between separate burials. The period of use of the necropolis was probably approximately 100-200 years in an undetermined part of the time span established by means of the calibrated dates. At the current state of knowledge, it is extremely problematic to give a more precise interpretation of the results due to the limitations of the radiocarbon dating method itself.

One of the available methods that allows us to attempt a more precise dating is wiggle matching. It makes it possible to obtain significantly more precise dates than with individual ^{14}C measurements. This method is used when there are at least two samples of an ascertained age difference (Pearson 1986; Walanus and Goslar 2009). The most reliable material for such analyses are wood fragments or charcoal pieces with visible annual rings found in sealed features on archaeological sites. If it is possible to take samples containing a single tree ring each (or a small, determined number of rings) and to count the number of rings between the samples, the period of time that separates the tested material is known. The objects unearthed in the Gajowizna cemetery make that possible, thanks to the traces of fire within the features: overheated loess and burnt beams (Figs 4 and 11). These were recorded in five funerary chambers (1, 13, 23, 28 and 30) and in the corner of one sacrificial pit (4). Moreover, bark was found in two features (28 and 30). All of the above provided a unique opportunity to carry out dendrochronological analyses of Late Neolithic materials, which resulted in the identification of the tree species and the evaluation of the age of the trees at the time when they were cut down. Such analyses were carried out in the Laboratory of Dendrochronology at the Centre for Research and Conservation of Cultural Heritage of the Nicolaus Copernicus University in Toruń on four samples from two graves located in the western part of the cemetery, which were included in complex 28-29-30-31. The materials from the other features have gone missing or disintegrated in storage.

The identification of the species of the samples is based on the microscopic observation of the anatomy of the wood in three sections: transverse, tangential and radial. The preparation of each sample allowed for the observation of separate sections. In the case of the wood from Feature 30, the radial section is the only one that has not been deformed, and that provided the necessary information to identify the species of the tree. The observation was carried out with a biological microscope in indirect as well as lateral light, at a magnification of between 40x and 400x. The results of the identification were further verified based on reference materials and the atlas of wood anatomy (Schweingruber 1990). All four analysed samples were identified as Scots pine (*Pinus sylvestris* L.). As evidenced by the growth rings, the trees grew in the favourable, stable environment of a low-density forest with plenty of sunlight.

Charcoal for radiocarbon dating was successfully extracted from three selected rings (outer, middle and inner) of the sample from Feature 28, which resulted in three absolute age determinations, separated from one another by an ascertained period of time. For the aforementioned calibration method, the age difference of the samples should be as long as possible. Due to the limitations resulting from the material, 15 years was the assumed minimum time span between the analysed tree rings. Three samples, each of which represented one tree ring, were sent for radiocarbon dating (Fig. 11). The following dates were obtained: 4500±40 BP for the inner ring, 4500±35 BP for the middle ring and 4480±35 BP for the outer ring. The application of unmodelled calibration gives the results of 3356-3033 BC, 3355-3091 BC and 3342-3029 BC, respectively (2σ, Table 2). Those time spans are slightly narrower than the calibration of the dates obtained from the bones, which results from the fact that the absolute age determination of Feature 28 is marked on the calibration curve before the plateau. Still, the obtained calibration range is quite broad, especially in reference to the most interesting outer tree ring. However, the *a priori* knowledge of the stratigraphy of the samples made it possible to apply the wiggle matching method using OxCal, v. 4.3, software (Bronk Ramsey 2001) to estimate the absolute age and narrow down the BC spans, which is particularly clear in the case of two extreme tree rings, for which the difference between the unmodelled and modelled calibrations is almost 100 years, with a probability of 95.4% (Table 2, Fig. 12). This is particularly important, because it has facilitated a more precise determination of the age of the outer ring, which defines the approximate date when the tree was cut down and then deposited in the funeral pit.

It remains problematic, however, that the 3321-3090 BC date is older by almost 200 years than the other results of radiocarbon dating obtained from the bones found in the same cemetery. It is difficult to unambiguously point to the reasons for such a situation. Theoretically, the result should prove the older age of Feature 28 within the necropolis in question. Most likely, however, the older age of the discussed sample results from the specificity of the organic material, *i.e.*, wood. The old wood effect is often addressed in publications (*e.g.* Pazdur and Pazdur 1982, 29; Schiffer 1986; Pospieszny 2009, 79; Biehl and Nieuwenhuyse 2016, 197-200). This thesis is further supported by the date obtained from Feature 31, which is included in the same ritual complex. The result of 4180±40 BP, or 2891-2631 BC, was obtained from a bone of an animal deposited there, which is similar to the other radiocarbon age determinations acquired from the Gajowizna cemetery. Observations from grave VIII at the Sandomierz-Kruków site (Sandomierz, site 78), where the age determinations of human bones are later than those of charcoal that was also found in the feature (Witkowska in print), exemplify the problems resulting from the juxtaposition of age determinations obtained from different materials. With caution arising from the developmental differences in other regions, the observations of earlier dates obtained from charcoal may also be made for series of age determinations from other areas occupied by the GAC (Szmyt 1996, 65; Włodarczak 2016, 540).

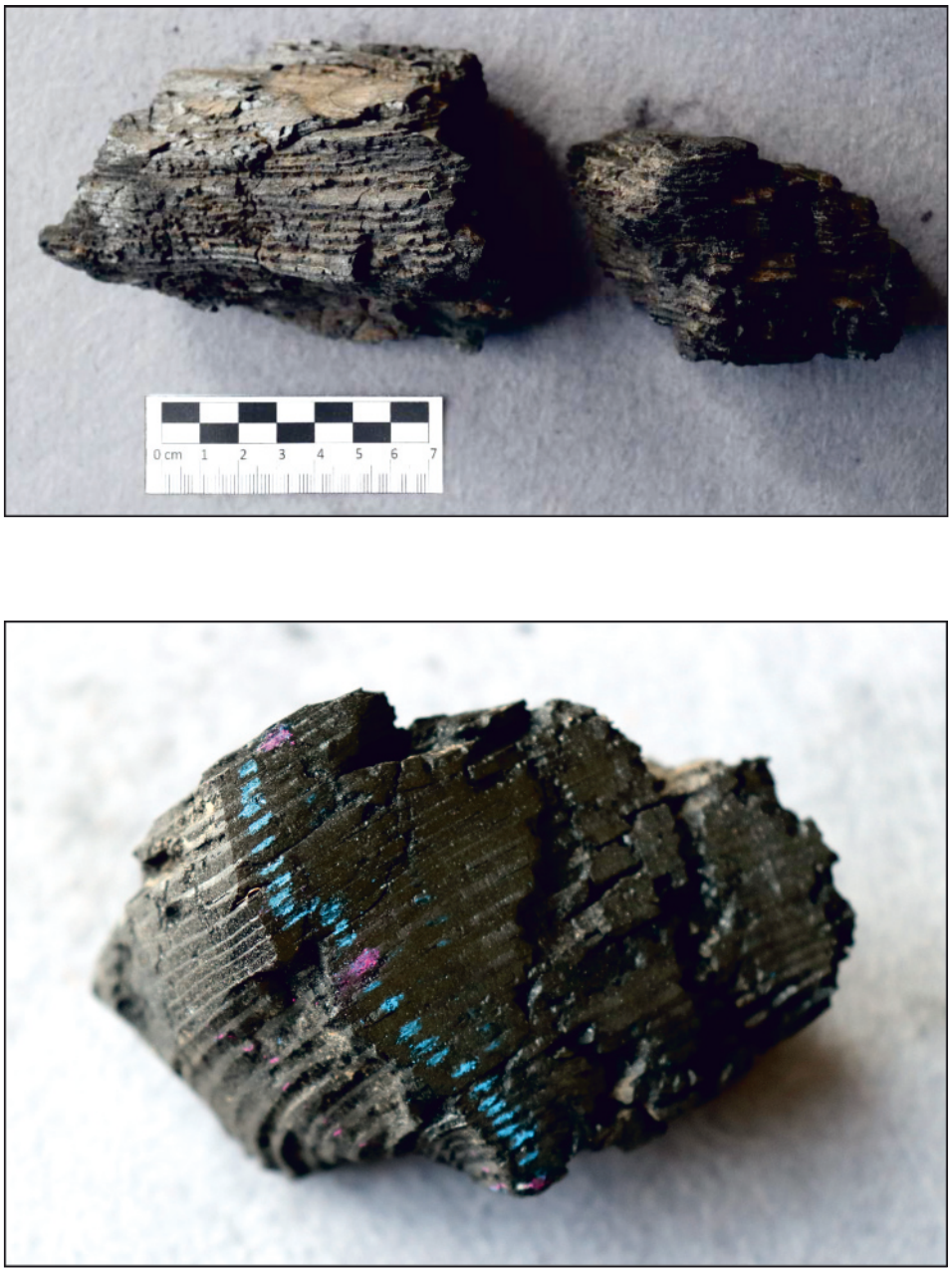

Fig. 11. The Gajowizna site.
Fragments of burned wooden beams found in Feature 28
(photo by B. Gmińska-Nowak)

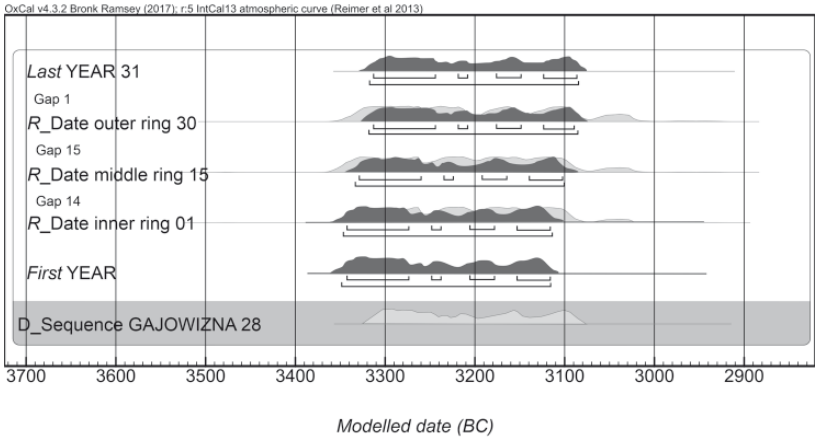

Fig. 12. The Gajowizna site. The calibration with wiggle matching method of three radiocarbon dates from a fragment of beam found in Feature 28

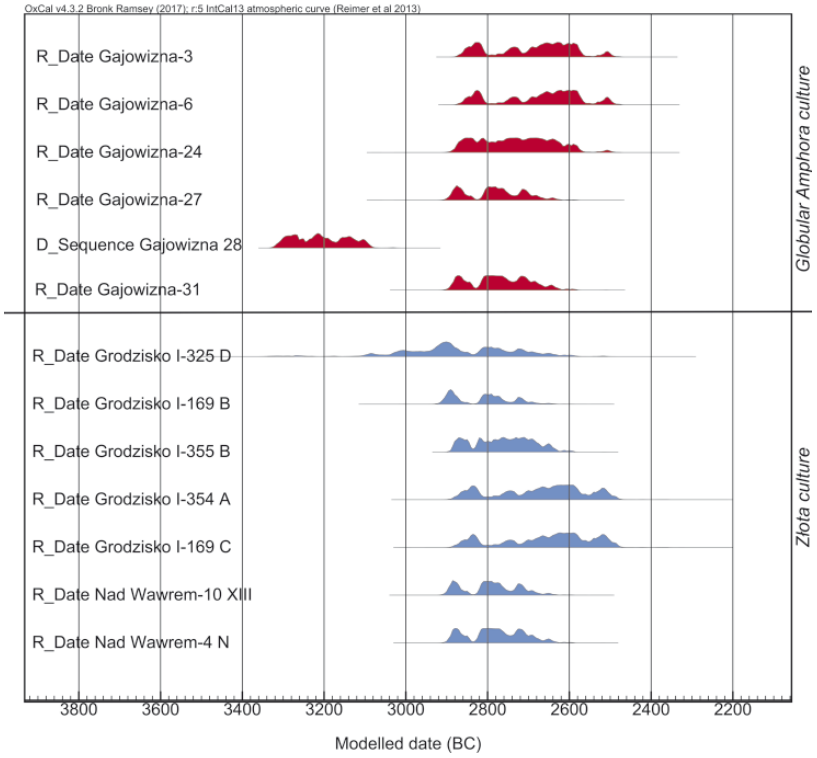

Fig. 13. Comparison of radiocarbon dates of the GAC (red) from the Gajowizna site and absolute age determinations of Złota culture graves (blue) from cemeteries Nad Wawrem and Grodzisko in Złota (Złota culture dates after Krzak 1989)

The first absolute age determinations of the Gajowizna cemetery features allow us to include the necropolis in the chronological pattern of the Late Neolithic in the Sandomierz Upland. As many as 42 absolute age determinations have been obtained so far from GAC features, out of which 18 came from sepulchral sites (Witkowska in print). Almost all of them were obtained from osteological materials and correspond to the calibration span of the series of age determinations from the Gajowizna site, *i.e.*, to the period between 2900 and 2600 BC, which is most likely the time when the necropolis was utilised. This absolute chronology of the GAC ritual site poses an important research problem, since it overlaps with the age determinations of the Złota culture graves (Fig. 13; Krzak 1989; Włodarczak 2019, 193, table 4, fig. 7) discovered in the vast cemeteries located in Złota, less than a kilometre away from the Gajowizna site: Grodzisko I and Nad Wawrem (Fig. 1). The above observation leads to the question regarding the nature of the relations between the groups of people who were using the neighbouring necropolises. Two possible hypotheses should be considered: the coexistence of two populations that followed different funeral scenarios, and the succession of the two cultures. The insufficient precision of the calibration curve makes it impossible to falsify either of the above hypotheses with the radiocarbon age determination method. The question of the possible two phases of use of the GAC cemetery also remains unanswered. Due to the relatively narrow timeframe presumed for the GAC of south-eastern Poland (Włodarczak 2016; Witkowska in print, for different opinion *cf.* Bronicki 2019) and the present inaccuracy of the calibration curve, answering the above and determining the sequence of burials on the Gajowizna site seems rather impossible with the application of radiocarbon chronometry.

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