Recherches Archéologiques
NS 10, 2018 (2019), 21–78
ISSN 0137 – 3285
DOI: 10.33547/RechACrac.NS10.02

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Contextualisation of the Early Iron Age hoard of bronze objects discovered in Gdynia-Karwiny, site 1

Abstract: After the amateur discovery of a hoard of bronze ornaments (a kidney bracelet and two hollow ankle rings) in 2014 in a forest near Gdynia (Pomerania, northern Poland), the place was subjected to excavation. It turned out that in the nearest context of the bronzes (which had been found arranged one on top of the other in a narrow pit reaching 60 cm in depth) there was a cluster of stones, some of which could have been arranged intentionally in order to mark the place of the deposit. Next to this alleged stone circle there was a deep hearth used to heat stones, and for burning amber as incense. Remains of amber were preserved in the form of lumps and probably also as a deposit on the walls of some vessels. Some of the features of the examined complex may indicate a non-profane nature of the deposit: the presence of the stone structure, traces of burning amber, the location of the deposition spot in a not very habitable flattening of a narrow valley, as well as the chemical composition of the alloy of metals themselves. The ornaments were made of a porous copper alloy with a high addition of lead, antimony and arsenic, which could promote their fragility and poor use value. However, the ceramics found near the place where the bronzes are deposited do not differ from the settlement pottery of the time. The hoard and its context should be dated to the transition phase between the periods HaC1 and HaC2 (the turn of the 8th and 7th cent. BC). The Gdynia-Karwiny deposit adds to the list of finds from a period marked by the most frequent occurrence of hoards in Pomerania (turn of the Bronze Age and the Early Iron Age). Its research seems to contribute to the interpretation of the deposition of metal objects as a phenomenon primarily of a ritual nature, and at the same time a social behaviour: a manifestation of competition for prestige.

Keywords: hoard, bronze ornaments, Early Iron Age, archaeological verification, Pomerania

1. Introduction

One of the most burning problems in contemporary conservation of archaeological heritage is the activity of detectorists or "treasure hunters", i.e. amateurs who use metal detectors to explore – for hobby or less often for money – places of historical importance, including archaeological

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sites. The majority of bronze hoards discovered recently are result of precisely such explorations (cf. Maraszek 2006, 82; Maciejewski 2016, 24, fig. 4), most often undertaken illegally. The illegality of such actions aside, for such a specific category of archaeological sources as deposits of metal objects (hoards) they create a number of problems of methodological nature. Most important among them is the unprofessional extraction of the discovered artefacts, which results in significant loss of research potential, even if the discovery is later reported and the artefacts are handed over to proper institutions. The situation is even more acute if we consider that so far, despite nearly 200 years of archaeological interest in the phenomenon of hoarding in the Bronze and Early Iron Ages, the majority of such discoveries have been made in amateur circumstances (in the past mainly during agricultural and engineering works, and today mainly due to amateur explorations), and the artefacts themselves have been recovered without sufficient documentation or any kind of sampling strategy. Therefore, our knowledge about circumstances of hoards' deposition still remains far from satisfactory or is simply insignificant.

In these circumstances, the fact that explorers have started to organise themselves in associations and organisations should be seen as a positive tendency. These associations aim to legalise their activity by applying for permissions, which are typically granted by heritage protection services on condition of providing the supervision of an archaeologist. The situation described in this paper only partly reflects an ideal one, in which the finding of a hoard (or any other archaeological find) during a planned and supervised survey would be followed by methodically correct procedure of archaeological excavation (cf. Maciejewski 2018) rather than its hastily retrieval.

Fig. 1A. Hoard of bronze ornaments discovered in 2014 in Gdynia-Karwiny (before conservation). "Top" surface of the ankle-rings is shown. Photo K. Dzięgielewski

The verificatory excavation of the place of the hoard's discovery in the forest at Gdynia-Karwiny in 2014 was undertaken, among others, to make amateur explorers aware (by involving them in the research process) of the cognitive potential promised by this modern approach.

2. Circumstances of discovery and history of research

In February 2014, the Sopot-based *Invenire Salvum* Foundation was approached by a person involved in amateur metal detector searches for military objects from WWII. While exploring the area around a German artillery site in Witomino Forest on the Kacza River, the man found a hoard of bronze objects originating from the Early Iron Age. These were two hollow rings of arm-ring size, and a similarly shaped kidney bracelet (Fig. 1), which the finder retrieved from the ground himself and, after some time, anonymously handed over to the foundation. The foundation, at that time cooperating with Dr Anna Longa as a supervising archaeologist, reported the fact to the Provincial Heritage Protection Office in Gdańsk. Also on the initiative of the foundation, an application for archaeological excavations in the place of the hoard's discovery was submitted in May 2014. The permission for carrying out excavations allowed field research to be launched, with the preliminary excavations led by Dr Anna Longa performed on 7 June 2014. The revealed archaeological structures were documented and secured for further exploration. The second stage of verificatory excavations, conducted between 29 and 31 of July 2014 in cooperation with the Institute of Archaeology of the Jagiellonian University in Kraków, involved the exploration of the features and the entire area of the trench (40 m^2 in total). Members of *Invenire Salvum* members, in particular Marcin Tomaszewski, helped in the excavation process. During this second stage of research, an episode of the TV programme "Poszukiwacze Historii" was produced by TV station Polsat Play, with Rafał Czapliński as director.[5] The hoard and the materials from excavations are stored in Archaeological Museum in Gdańsk.

3. Inventory of the hoard

3.1. Description of the inventory

1. Bronze ankle ring, hollow, open, cast, decorated (Figs 1B: 2, 1C, 2, middle); wall thickness from 0.15 to 0.2 cm, circular in topview, 17.3×17.2 cm, oval in side view, with the height from 5.2 to 6.8 cm, narrowing towards the open ends. In cross-section it resembles the letter D open from the inside, pointing with the rounded part to the outside; from the inner side there is a slit-like opening along the perimeter, which was used for removing the clay core, with the edges slightly thinned relative to the wall thickness, having the height ranging from 0.7 cm (at the ends) to 2.9 cm (in the middle). The open ends are straight but not vertically parallel, with the distance between them being 0.5 cm at the "bottom" and 1.2 cm at the "top"; horizontally, the ends are shifted by approx. 0.1–0.2 cm; by each end, the ring is decorated over a length of approx. 5 cm. The decoration is symmetrical but not identical, and it includes three groups of plastic (cast) motifs. The first group is comprised of a protuberance next to the edge

[5] The episode is available at: https://www.ipla.tv/wideo/wiedza/Poszukiwacze-historii/5003107/Poszukiwacze-historii-Kultura-pomorska/08f5f8cc721ba24859311f064cceee52?seasonId=5003107

(0.3–0.4 cm thick), which gradually disappears towards the inner side of the ring, accompanied by two parallel ribs up to 0.1 cm high (in one place, on the "top" side, a section of a third rib can also be seen). The second group, between 1 and 1.6 cm from the last rib of the first group, includes three parallel ribs up to 0.1 cm high. Finally, the third group, from 0.9 to 1.4 cm from the last rib of the second group, comprises a vertical row of roughly circular, flat knobs 0.3–0.4 cm in diameter and up to 0.1 cm high; there are 13 knobs (and they are slightly larger on average) on one end of the ring, and 16 on the other end. The groups of ribs gradually disappear on the inner side of the ankle ring. The positions of the groups of motifs are not the same on both ends. At one end, between two groups of grooves, there is a rectangular trace of a cast-on repair on the upper edge (Fig. 1B:2a); a possibility that the repair has been made by hammering a piece of bronze sheet to cover the missing part is less likely – there are no detectable traces of hammering, and the cast-on is also visible from the inside of the hollow ring, and has 2 poorly defined protuberances on the inner side. The wall in the repaired place is thicker by approx. 0.2 cm. The inner edge of the slit had been slightly cut off, perhaps to facilitate making the cast-on. The ankle ring is fully preserved, with a crack 4.7 cm long at one end. Weight (before conservation): 520 g. Field inv. no.: GKA1/1; museum no. MAG/WEZ/4014/1/1/562.

2. Bronze ankle ring, hollow, open, cast, decorated (Figs 1B: 1, 1C, 3, bottom); wall thickness from 0.15 to 0.2 cm, circular in topview, 17.3×17.4 cm, oval in side view, with the height from 6.1 to 7 cm (7.8 cm at the damaged/flaring end), narrowing towards the open ends. In cross-section it resembles the letter D open from inside, pointing with the rounded part to the

Fig. 1B. Gdynia-Karwiny, site 1. Hoard of bronze ornaments (after conservation at the Gdańsk Archaeological Museum). "Bottom" surface of the ankle rings is shown. Photo P. Fudziński [1–3] and A. Kamrowski [2a]

Fig. 1C. Gdynia-Karwiny, site 1. Bronze ornaments according to their original arrangement in the hoard. Photo A. Kamrowski, photography credits: Muzeum Archeologiczne w Gdańsku

outside; from the inner side there is a slit-like opening along the perimeter, which was used for removing the clay core, with edges slightly thinned relative to the wall thickness, having the height ranging from 1.6 cm (at the undamaged end) to 2.4 cm (in the middle). The open ends are straight but not vertically parallel, with the distance between them being 0.7 cm at the "top" and 0.2 cm at the "bottom"; horizontally, the ends are shifted by approx. 0.6 cm; by each end, the ring is decorated over a length of approx. 4.5 cm. The decoration is symmetrical but not identical, and it includes three groups of plastic (cast) motifs. The first group is comprised of a protuberance next to the edge (0.3–0.4 cm thick), which gradually disappears towards the inner side of the ring, accompanied by two parallel ribs up to 0.15 cm high. The second group, between 0.9 and 1.4 cm from the last rib of the first group, includes three parallel ribs up to 0.1 cm high. Finally, the third group, from 0.4 to 1.4 cm from the last rib of the second group, comprises a vertical row of roughly circular, flat knobs 0.3–0.4 cm in diameter and up to 0.1 cm high; there are 16 knobs at each end of the ring. The groups of ribs gradually disappear on the inner side of the ankle ring. The positions of the groups of motifs are not the same on both ends. The ankle ring has been damaged, probably at the moment of its discovery, which may stem from its position at the very bottom of the pit in which the hoard was placed and from the object being most severely disturbed by plant roots, especially from the bottom side, which lay directly in the sand. The damaged part includes a section approx. 9 cm long near one of the ends. Total weight (before conservation) of all fragments: 570 g. Field inv. no.: GKA1/2; museum no. MAG/WEZ/4014/1/1/563.

3. Bronze kidney bracelet, closed, hollow, cast, decorated (Figs 1B: 3; 1C, 4, top); wall thickness from 0.5 to 1.5 cm, oval (D-shaped) in topview, with the "flat" part with a kidney-shaped protuberance in front; dimensions: 8.4 (8.9 in the thickened part)×9.9 cm, oval in side view, with the height ranging from 1.6 (2.7 in the thickened part) to 3.9 cm; the bracelet tapers towards the "front" part with the protuberance; the cross-section resembles the letter D (with the rounded part to the outside), passing to triangular, especially in the "back" section of the bracelet; the slit-like opening for removing the clay core is not continuous: in the "front" part the wall is closed, with the remains of an unremoved clay core still inside (visible through a hole in the damaged central part of the protuberance). Decoration: centrally placed kidney-shaped protuberance, 1.9 cm thick and 2.7 cm high, with a single vertical rib with smooth edges. The protuberance is flanked symmetrically (2 cm on each side of the "kidney's" centre) by single plastic ribs with smooth edges. All the ribs are up to 0.1 cm high and gradually disappear towards the inner side of the bracelet. Additionally, outside the flat, kidney-shaped part, there are two circumferential ribs with smooth edges, up to 0.1 cm high. Seen in cross-section, the inner of these ridges marks the place where the bracelet's profile bends to inside. The bracelet is partly damaged: the largest missing element is a hole 0.3–0.4×1.9 cm in size in the central rib on the kidney-shaped part, and there also are a few smaller holes and fractures along the bracelet's perimeter. Weight (before conservation): 130 g. Field inv. no.: GKA1/3; museum no. MAG/WEZ/4014/1/1/564.

3.2. Typological-functional characteristics

According to the account of its discoverer, the hoard found in the forest in the valley of the Kacza River in Gdynia was comprised of three bronze artefacts placed one on another. They comprised a pair of large ring ornaments with a single bracelet lying on them (Fig. 1; 27:1). The former are referred to as hollow ankle-rings, although they are cast rather than hammered

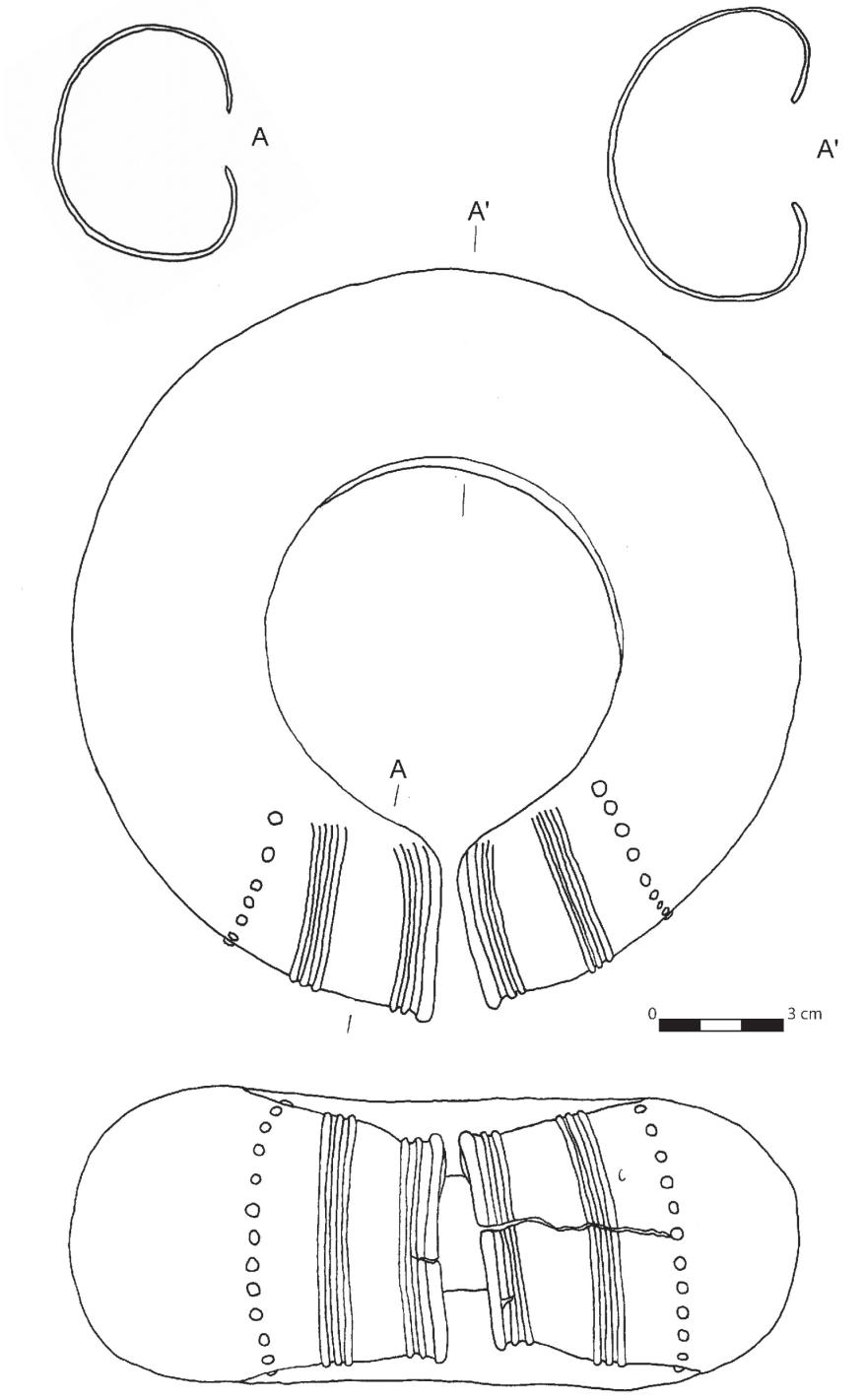

Fig. 2. Gdynia-Karwiny, site 1. Ankle ring no. 1. Drawing by J. Religa-Sobczyk

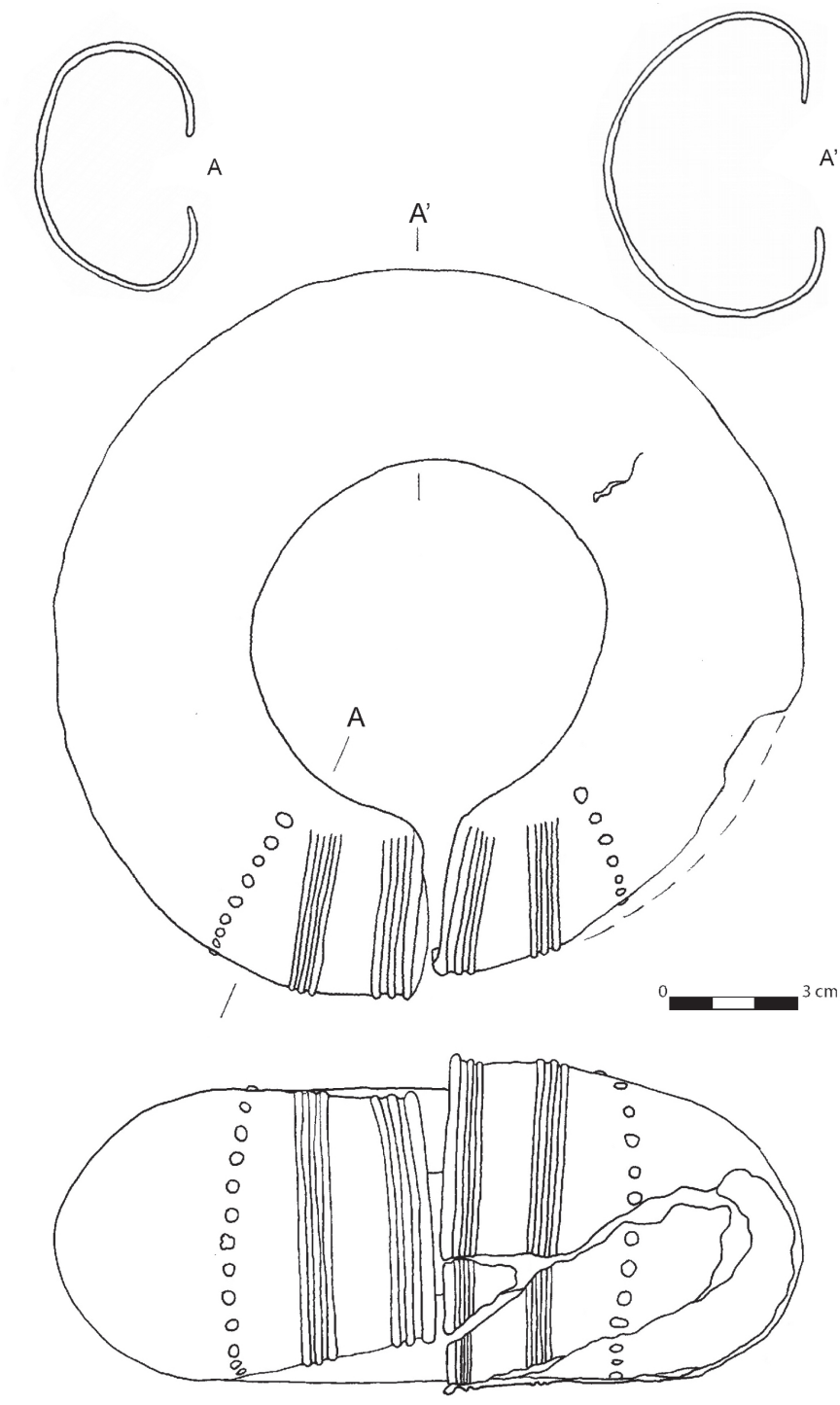

Fig. 3. Gdynia-Karwiny, site 1. Ankle ring no. 2. Drawing by J. Religa-Sobczyk

from sheet metal. The ends of these ornaments are very close to each other but do not actually meet. The rings reach 17 cm or slightly more in diameter and are approx. 6–7 cm high (Fig. 2–3). It remains unclear whether they indeed were worn as ankle rings, or possibly as arm rings. The identity of the bearers of such ornaments is suggested by slightly later finds from northern Germany, where a number of such objects have been discovered in graves characterised by a female model of furnishings (Schacht 1982, 18–19). Unfortunately, these were cremation burials (in urns), which does not allow the way these massive rings were worn to be reconstructed. As it is with many other examples (Schacht 1982, 35), neither do the ornaments from Gdynia-Karwiny show clear traces of usage (broken off or worn out places, etc.) which would probably emerge, especially when worn on legs. Thus, it is quite likely that the rings were created with the intention of burying them in the ground, and if they were used (what may be suggested by patching of one of the ends), it was only as a means of signalling the status of a person or a certain social group (Dzięgielewski 2017, 305). The fact that they were not objects of everyday use is confirmed by the analysis of the alloy from which they were made, which revealed – apart from the dominant copper – high percentages of lead and antimony, elements greatly increasing the brittleness of bronze (see further in the text). Both rings are decorated in analogical manner: with two groups of plastic ribs and single rows of small, roughly circular knobs at each end. They were certainly designed and cast as a set. Among the 250 ornaments of this type known from the southern coasts of the Baltic, identical decoration can only be seen on a set of ankle rings from Trąbki Wielkie near Gdańsk (Lissauer 1891, 17, pl. VI: 2–7). It cannot be ruled out that both sets were created by one and the same craftsman.

Thus, in terms of morphology and typology both ankle rings belong to the same category. The history of research on this group of ornaments can be traced back to the late 19th century (e.g. Schumann 1892). In the currently most popular typological system (and the only one based on a relatively complete list of finds), developed by S. Schacht (1982), the ornaments from Gdynia-Karwiny would fall within type C, where specimens decorated at the ends with plastic ribs and other motifs (knobs included) belong. However, this typology may be questioned on the grounds that Schacht divided the ornaments according to only one criterion, namely the manner of decoration. The result was that rings of different functions (of the size of bracelets, ankle rings, and even necklaces) were classed within a single "type". This typological approach also blurs a line of development – quite typical of the circum-Baltic milieu at the turn of the Late Bronze and Early Iron Ages – in which original ornaments are relatively small to later grow in size in subsequent phases (cf. Dzięgielewski, in preparation). Furthermore, the criteria of division adopted by Schacht made her typological system insensitive to regional differences – she encompassed the bulk of the motifs characteristic of particular areas of the southern Baltic coasts within one type (C). A recently developed alternative classification system (Dzięgielewski, in preparation) relies on function-size and morphology (diameter to height and thickness to height ratios) as the basic criteria. Ornaments which given their inner diameters could have been used as necklaces have been set aside. The remaining artefacts fall within the size range typical of bracelets, arm rings, and ankle rings (inner diameter of 7–10 cm), and it is precisely this latter group in which the objects from Gdynia-Karwiny should be included. Like the mentioned artefacts from Trąbki Wielkie, the analysed rings represent the most numerous morphotype, referred to in Dzięgielewski's classification as the Reda-Rekowo type. These are rings marked by a distinctly D-shaped cross-section, and stockiness and robustness typical of the late stadium of the development of such ankle rings in Pomerania. As for ornamentation, the motifs predominant in this type include between one and three groups of transversal ribs at the ends. The addition of a row of knobs (Trąbki Wielkie, Gdynia-Karwiny, Janowice,

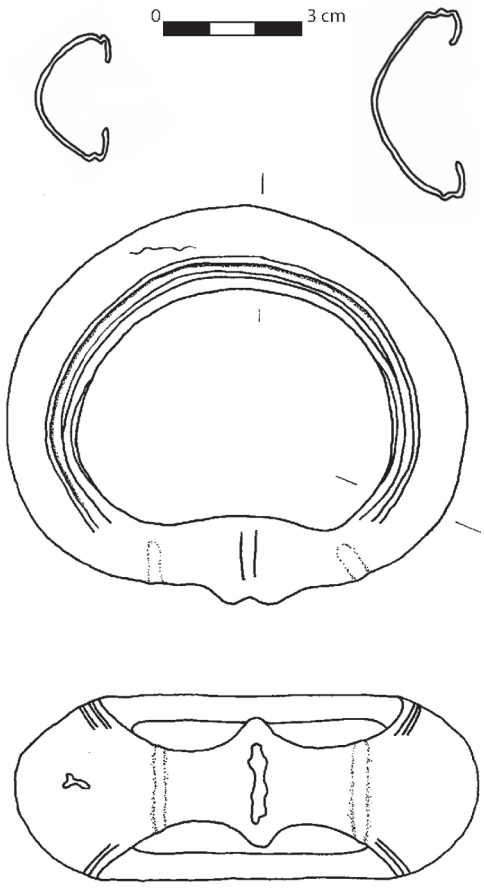

Fig. 4. Gdynia-Karwiny, site 1. Kidney bracelet no. 3. Drawing by J. Religa-Sobczyk

Gniewino, Papowo Biskupie) should be seen as a regional feature, limited almost exclusively to the Kaszuby Lake District (and exceptionally the Chełmno region).

The bracelet found in the Gdynia-Karwiny hoard belongs to late "kidney" bracelets, a name applied to closed ring ornaments worn on arms, distinguished by an oval protuberance resembling a kidney in the centre (Fig. 4). The bracelet is oval, approx. 9×10 cm, and from 1.6 to approx. 4 cm high, with the kidney-shaped part distinctly pushed inside the oval, which is characteristic of late morphotypes of such bracelets (of Early Iron Age date). In the middle of the protuberance and on both its sides there are delicate plastic ribs. Other, nearly circumferential ribs adorn the edges of the bracelet. The bracelet was manufactured in a manner similar to the ankle rings discussed above, which means cast using the lost wax technique. As with ankle rings, kidney bracelets also have a long history of research and have been the subject of a number of studies (cf. Dzięgielewski, in preparation). Among the most useful ones is that by A. Tyniec (1990a; 1990b), devoted to North European bracelets from both the Bronze and Early Iron Ages. In this approach, the Gdynia-Karwiny bracelet would fall in type IBb (Tyniec 1990b, 28–29, table 1). Late kidney bracelets, of Iron Age date, have been most comprehensively characterised by K. Tackenberg (1971, 220–224), and in this classification the bracelet from Gdynia-Karwiny would represent variant 1. Furthermore, based on the two systems presented above, S. Pabst-Dörrer (2000, 73) developed her own classification. The same applies to the most recent, yet unpublished proposition (Dzięgielewski, in preparation), which relies on morphological-metrical criteria. In this latter classification the Gdynia-Karwiny bracelet represents the Gniewino type, distinguished by a deep C-shaped cross-section with the edges strongly bent towards the inside. The main variant of the Gniewino type is gently rounded in section, sometimes with slightly profiled tops due to the presence of decoration in the form of circumferential ribs. The kidneys are typically oval in side view, and are decorated with vertical, hatched ribs.

In a seriation analysis of hoards from Pomerania performed in the cited study (Dzięgielewski, in preparation), the hoard from Gdynia-Karwiny, which comprises two morphotypes of Early Iron Age ornaments (the rings of the Reda-Redzikowo type and the bracelet of the Gniewino type), is placed in a sector linked with sub-period HaC1b–C2a, in the immediate vicinity of such

Pomeranian hoards as Trąbki Wielkie (Lissauer 1891, 17, pl. VI: 2–7), Gniewino (Kozłowska-Skoczka 2012, 174–175), Janowice (Kunkel 1931, table 44), Mieroszyno (Lissauer 1891, 15, pl. VI: 12–15), Nętno (Rembisz 2009), Podwilczyn (Stubenrauch 1897), Wąsosz (Kostrzewski 1958, fig. 150), Kazimierz Pomorski (Lachowicz 1978), and Kiełpino (Kozłowska-Skoczka 2012, 179–181). Of the two morphotypes, the bracelet shows closer correlation with assemblages datable to HaC1b, while the hollow ankle rings link more to assemblages dated to HaC2a. Therefore, theoretically the latter should determine the younger chronological position of the hoard in question (HaC2a). However, due to the nature of seriation analysis – which allows for a general orientation rather than for setting a given assemblage on the timeline in absolute terms (cf. Trachsel 2004, 9–20) – it is also possible that the hoard was buried at the close of HaC1. The dating of hollow rings proposed here is considerably earlier than the views prevalent in the Polish-language literature to date, which attempt to link hollow ornaments *en masse* with the classic phase of the Pomeranian culture and with the Late Hallstatt period (cf. Łuka 1966, *passim*; Blajer 2001, 357–370; Fudziński P., Fudziński M. 2010), but it allows for a much better synchronisation of Pomeranian hoards with chronologies of many other categories of metal artefacts, which in recent decades have been established for other areas of Central Europe (cf. Pabst-Dörrer 2000; Trachsel 2004). This proposition also corresponds well with recent revisions moving back the absolute chronology of Hallstatt period phenomena throughout Europe (cf. Dzięgielewski 2017, 297).

3.3. Results of chemical analyses of the bronzes

In 2014, all the artefacts from the Gdynia-Karwiny hoard were subjected to spaectrographic examination in the Laboratory of Conservation and Archaeometallurgy of the JU Institute of Archaeology in Kraków.[6] Metal composition was analysed with a small spot energy dispersive Spectro-MIDEX XRF spectrometer, using X-LabPro software (TURBO QUANT). Alloy composition was determined in selected spots on the outer surfaces of the ornaments, from which corrosion layers had been previously mechanically removed. Each of the ankle rings was sampled in two spots on their conventional "top" surfaces (Fig. 1A), on opposite sites, outside the decorated area (measurments 1A, 1B, 2A, 2B). The bracelet was sampled in three spots: on the top of the kidney (measurement 3C), in the back (measurement 3A), and on the "top" surface opposite the kidney (measurement 3B[7]). The measurement results are presented in the table below.

Artefact	Measurement	Cu %wt	Sn %wt	Pb %wt	Sb %wt	As %wt	Ag %wt	Ni %wt	Bi %wt
Ring 2	1A	86.41	0.917	3.910	3.869	1.779	1.629	0.586	nd
Ring 2	1B	85.92	0.822	4.622	3.548	2.097	1.516	0.545	nd
Ring 1	2A	83.91	0.591	6.888	4.110	2.044	1.558	0.675	nd
Ring 1	2B	83.72	0.584	7.212	3.660	1.865	1.524	0.579	nd
Bracelet	3A	86.96	nd	0.573	4.237	5.310	1.871	0.845	0.104
Bracelet	3C	88.77	nd	0.416	3.468	4.303	1.727	1.061	nd

Included in the table are only the elements whose percentages exceeded 0.1%.

None of the examined artefacts were made of tin bronze. In the hollow ankle rings, the main alloying element was lead (with mean values for rings 1 and 2 at 7.05% and 4.27%,

[6] The analyses were carried out by Dr hab. Marcin Biborski, whom we would like to heartily thank here.

[7] Since this measurment greatly diverged from other results, and due to unusually high proportion of arsenic, the measurment has been rejected as unreliable.

respectively), and a considerable addition of antimony (3.88% and 3.7%) was recorded as well. The percentages of arsenic and silver were high (exceeding 1.5%), although this cannot be unequivocally regarded as resulting from intentional additions. The alloy from which the bracelet was cast contained a significant addition of antimony (with a mean value from 2 measurments at 3.85%), with a high proportion of As (4.8%). Therefore, we can speak of a lead-antimony bronze (CuSbPb – ankle rings) and an antimony bronze probably with a high natural arsenic content (CuSb – bracelet). The recorded proportions of antimony and arsenic may have given bronze objects a golden tint (Pike 2002, 90), although in the case of the ankle rings this was probably neutralized by the high proportion of lead, which changed their colour to white or grey. The arsenic in the bracelet increased the hardness of the alloy, although its presence does not seem intentional. Both metals, antimony in particular, are regarded as substitutes for tin, which could be used either when tin was lacking or when the intention was to cast artefacts distinguished by bright colours and resistance to matting, to be used for ostentatious signalling rather than actual intensive use (Maclean 1998). Apparently, in the case of the Gdynia-Karwiny ornaments the additions of antimony (and arsenic?) were not intended to facilitate further processing either. Admittedly, antimony improves cold malleability (Kucypera 2017, 88), but further hammering was most likely not planned at all for these massive cast ornaments. What was probably much more important for ornaments cast on a core was to lower the temperature at which crystallisation begins thanks to the presence of lead and arsenic, and to improve castability thanks to the addition of antimony (Garbacz-Klempka 2018, 236). These properties of the alloy could prevent premature solidification during the casting of a large but thin-walled (and therefore rapidly cooling in the mould) ornament. In the case of large ankle rings, even the high addition of lead (in theory making the alloy more plastic and facilitating the reduction of cracks) proved not enough to avoid porosity (and therefore weakening) of the cast. This probably did not work out due to insufficient contents of tin (Kucypera 2017, 85–86), and as a result the cast was highly porous. The addition of Sb along with As into the alloy may have also been intended to give the alloy a bright colour (Pike 2002, 92).[8]

However, the most probable explanation is that the recorded alloy composition reflects not the intended quality only, but also the characteristics of the available raw material, probably acquired from enriched sulphide ores (grey ores or so-called *Fahlerz*) (Pike 2002, 90). The metal itself undoubtedly originated from lumps or bars mass-imported to Pomerania at the turn of the Bronze and Early Iron Ages, which are known in large amounts from several hoards in Pomerania. The best known among them are: a deposit of approx. 100 copper "cakes" from Szpęgawsk (La Baume 1931), three pieces weighting in total approx. 4.2 kg from the Witkowo hoard (Schumann 1900, 142), and bronze rods-bars from Swarzewo (Kossinna 1919, fig. 33; La Baume 1931, fig. 3) and Słupsk (A. Krzysiak, personal information; Dzięgielewski 2017, 305). Each of the last two deposits contained approx. 150 rods-bars having an average length of 40 cm and weighing 30–70 g (the data for the Swarzewo hoard). For some of them old chemical analyzes are available (the artifacts themselves were mostly destroyed during World War II in Gdańsk). The degree of their reliability is difficult to determine due to the lack of detailed descriptions of the test methods in pre-war publications, but new studies of objects of similar class (e.g. rods-bars) are consisted with these old results. "Copper cakes" virtually always contained almost pure copper, although a single find of this type from Połchówko contained approx. 13% antimony (La Baume 1931, fig. 1k). In terms of chemical composition, more akin to the

[8] The authors express their gratitude to Assoc. Prof. Aldona Garbacz-Klempka, AGH – Science and Technology University in Kraków, for her valuable comments on the above section.

Gdynia-Karwiny ornaments are rods-bars from Swarzewo, for which two analyses are available (Kossinna 1919, 166). None of the samples revealed the presence of tin, instead revealing considerable proportions of other elements: lead (respectively in samples 1 and 2: 5.86% and 14.12%), antimony (3.4% in sample 2) and arsenic (3.52% and 3.62%). Thus, rods or bars of that type may have been the source of the raw material used for manufacture (certainly locally) of the ornaments in question. The raw material itself might originate from western Europe (cf. Bukowski 1998, 355; Dzięgielewski 2017, 305). This direction of supplies to Pomerania is clearly evidenced by the fact that in the Słupsk hoard the bars were discovered along with a few axes of Lower Saxonian provenance. It is worth recalling in this context that one of the fundamental characteristics of Late Bronze Age metallurgy in western Europe (in the Atlantic zone in particular) was the widespread use of lead bronzes, including some containing more than 20% Pb (cf. Montero *et al.* 2003). According to a widely shared view, the bulk of artefacts manufactured from such alloys were of hoarding or votive (e.g. large hoards of palstaves or Armorican axes) rather than utilitarian value.

4. Immediate context of the find

4.1. Site location and characteristics

Site no. 1 at Gdynia-Karwiny was established in connection with the discovery of the hoard of bronze artefacts in February 2014 (descibed at the beginning of this paper). The site was designated as no. 35 within AZP area 09-42. It is situated in the Witomino forests in the northern part of the Karwiny district, in the valley of the Kacza stream, and more precisely in its latitudinal section between the Gdynia – Kościerzyna railway line and the Tricity bypass. West of the railroad embankment and Krykulec hamlet (Fig. 5), in a place where the Kacza valley broadens, within the southern, steep slope of the valley there is a flat terrace elevated between 82 and 84 m a.s.l. (the Kacza channel itself is today nearly 10 m lower than the level of the terrace). The terrace is covered with rather sparse, artificially planted pine forest, and is dotted with trenches, craters, and artillery pits remaining from fighting during WWII (Fig. 6). The area occupied by the archaeological site cannot be determined (due to the forest cover and because no archaeological materials have been found on the surface), and the place where the hoard was found and where archaeological excavations were later carried out lies approx. 350 m to the west from the mentioned hamlet of Krykulec and approx. 80 m to the east from a cross at a fork in a forest road (Figs. 5–6). The precise geographical position of the site is N: 54º29’19’’, E: 18º29’03’’.

In June 2014, in the place where the hoard had been discovered an archaeological trench 5×5 m in size was opened, perpendicularly to the axis of the valley (Fig. 6). According to information the discoverer provided to the Invenire Salvum Foundation, the hoard was found approx. 2 m south-east of a low, horseshoe-shaped embankment detectable in the landscape.[9] The northern edge of the trench touched the southern margin of this embankment (Fig. 9: 1). The research carried out in July 2014 resulted in the removal of the forest litter and forest humus layer, and the exploration of a 20–30 cm thick layer beneath the humus, which was partly natural (bedrock) and in part bore traces of human activity (Figs 7, 9: 2). This was clearly

[9] The embankment should probably be linked with a German artillery post established in February-March 1945, left behind by the German troops retreating before the Soviet army attacking from the direction of the Kashubian Proglacial Valley.

confirmed by the discovery of pottery fragments and the uncovering of a hearth in the NW corner of the trench. Within the hearth, among mid-sized stones, the upper part of a large Early Iron Age vessel was found along with lumps of amber. Discovered in the remaining part of the trench, including near a hole identified by the discoverer as the place where the bronze objects had been found, were relatively numerous small and mid-sized stones and fragments of Early Iron Age pottery (Fig. 7). No further exploration of the recorded structures was undertaken at that time. In the next stage of research, in July 2014, the next arbitrary layer was explored (30–50 cm beneath the forest bed level).

Three anthropogenic structures were recorded at a level of 50 cm: the mentioned hearth (feature 1), a pit (feature 2), and a "stone circle", most likely connected with the place where the hoard had been buried (feature 3). The archaeological trench was extended by 3 m towards the south, thus expanding the total area under exploration to 40 m^2 (Fig. 8). However, in this part of the trench only a few potsherds were found, and stone structures recorded there did not appear to be intentionally arranged. On the other hand, traces of anthropogenic disturbances (irregular pits, disturbed arrangement of stones) were evident in the central part of the trench, near the "stone circle" (Figs 8; 9: 3).

The exploration of another arbitrary layer (50–70 cm) did not reveal traces of human activity, and the area was covered at that depth with glacial sand (layer 2) and gravel (layer 3). In places, e.g. by the eastern edge of the trench, patches marked by a different colour were observed, but these were natural structures (e.g. resulting from bioturbations like animal burrowing, tree roots, or processes of windthrow formation). The exploration of the entire trench was stopped at a depth of 70 cm, with only the surroundings of the identified archaeological features being explored deeper. The features were cross-sectioned, and each part was explored and photographically documented every 10 cm (with the drawing documentation made at the levels of 50 and 100 cm).

4.2. Archaeological features

Feature 1 – sunken hearth

The ceiling of the feature was first identified at a depth of 30 cm (level 2), where its outline was not yet discernible and the hearth manifested itself as a cluster of small and mid-sized (up to 30 cm) stones, among which large sherds occurred, mostly belonging to one storage vessel. At this level the cluster was approx. 80 cm in diameter. At a depth of 50 cm (level 3) the hearth's outlines became clearly discernible, resembling an irregular oval 105×64 cm in size (Figs 10, 11: 1, 12: 1). The actual dimensions of the feature were only revealed near the bottom (depth up to 100 cm), where the hearth took the form of a regular oval 80×68 cm in size (Fig. 12: 2). The size of the pit was limited by the presence of large, natural erratic stones in the bedrock (Fig. 12: 3), which had not been removed by those digging the pit for the hearth. In cross-section the hearth resembled an irregular rectangle up to 72 cm thick (52 cm from the level of discovery), with a slightly arching bottom and clearly distinguishable use levels and filled-in part (Figs 11: 3, 12: 3). The bottom layer, from 6 to 12 cm thick, was connected with the exploitation of the pit as a sunken hearth. It was built from dark sand highly mixed with tiny pieces of charcoal (with some larger fragments, allowing for taxonomical identification of the wood), and tiny lumps of burnt-out (natural?) clay (Figs 11: 2, 12: 2). The second layer of charcoal-saturated deposit, recorded slightly above the first one and separated from it by a layer of pure yellow sand up to 10 cm thick, need not have been connected with another phase of the hearth exploitation, but may have instead fallen into the pit during the process of its filling in.

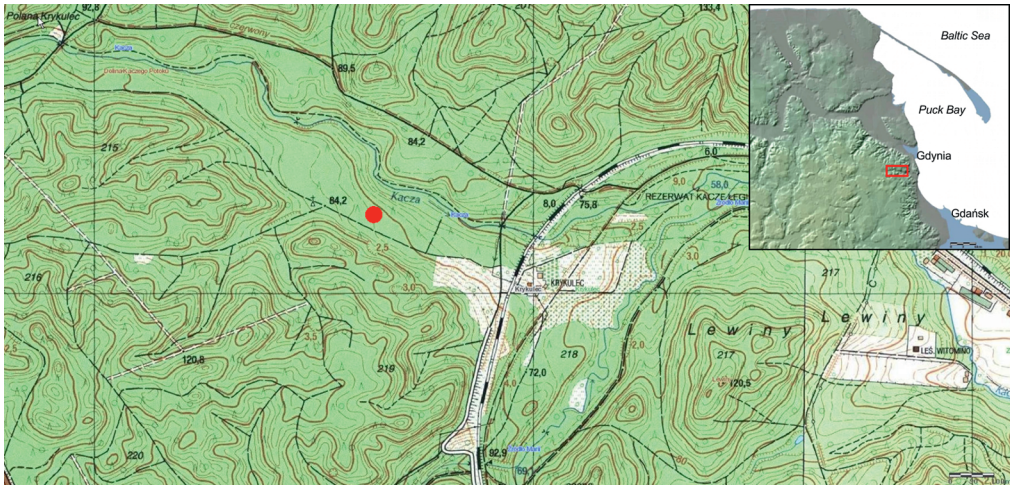

Fig. 5. Location of site 1 in Gdynia-Karwiny (AZP 09-42/35).
The source of the map: www.geoportal.gov.pl

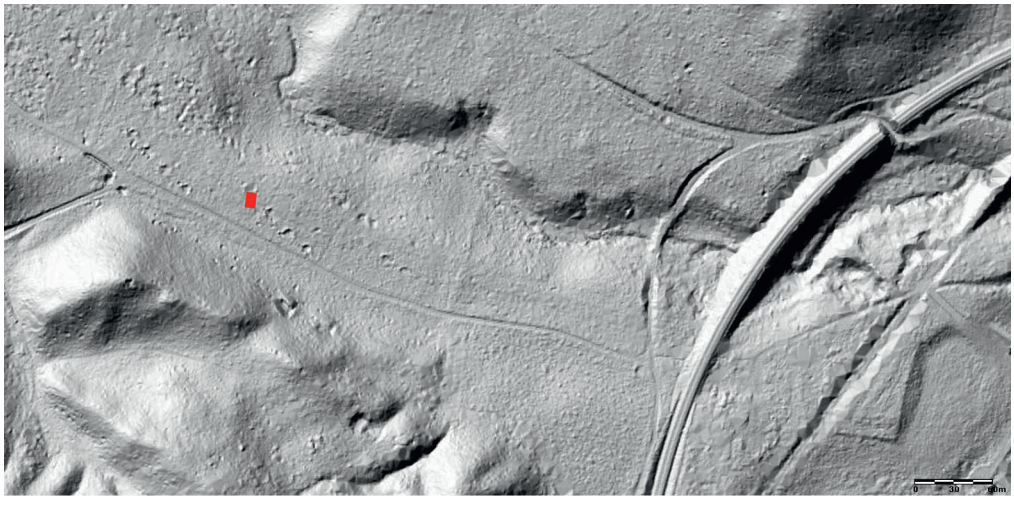

Fig. 6. Location of the archaeological trench at the place of the hoard's discovery at Gdynia-Karwiny.
The source of the map: www.geoportal.gov.pl, ISOK layer

The remaining, upper part of the fill, consisting of brown-yellow sand with gravel, partly mixed with humus, was undoubtedly secondarily filled back. In the ceiling of this deposit stones forming a relatively regular arrangement were recorded, which can be linked with the last phase of the feature's exploitation. The absence of clear traces of charcoal suggests that this youngest hearth was probably open (not sunken). The discovery among the stones of numerous fragments originating primarily from a single kitchen vessel may perhaps be indicative of using this place for cooking with "hot stones technology" (cf. Honeck 2009; Wierzbicki 2011). Smaller numbers of potsherds were also found during the exploration of deeper levels. Furthermore, in the upper part of the fill, at a depth of 20–30 cm, more than a dozen lumps of Baltic amber

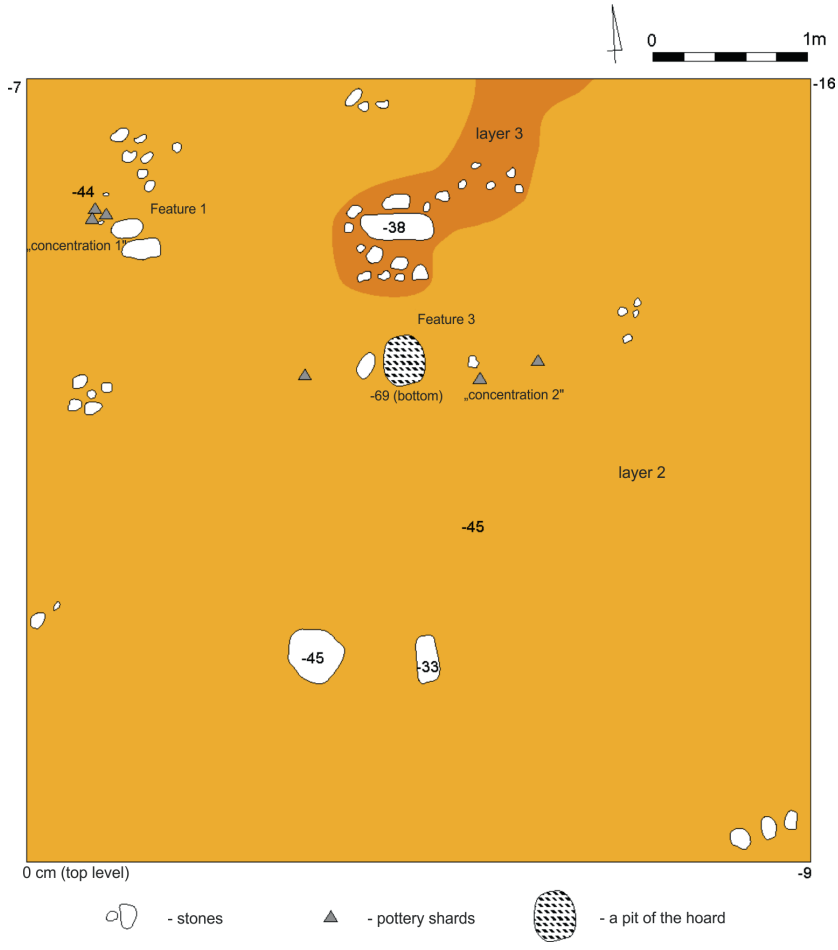

Fig. 7. Gdynia-Karwiny, site 1. Plan of trench 1 at level 2 (30 cm beneath the ground surface). Drawing by A. Longa and K. Dzięgielewski

were found. Smaller number of tiny amber lumps were also found at deeper levels, including in the charcoal-saturated layer at the bottom. This is evidence of intentional burning of amber (incensing) at all stages of the hearth exploitation.

Feature 2 – posthole?

The ceiling of the feature was recorded at a depth of 50 cm beneath the forest bed, approx. 0.5 m north of feature 1, by the northern edge of the trench (Fig. 8). At the level of its discovery the pit had an almost circular outline 50×60 cm in size, poorly discernible by its slightly more humic (brown and grey) sandy fill against the bright yellow bedrock. In the cross-section (in the N wall of the trench) two vertically arranged layers were discernible: light grey from the west and dark grey from the east, which together created a regular, vertical outline of what most probably was a posthole with traces of both the pit and the post discernible (Figs 11: 4, 13: 2). The fill reached 70 cm beneath the level of the forest litter; beneath it, an irregular and shallow

Fig. 8. Gdynia-Karwiny, site 1. Plan of trenches 1 and 2 at level 3 (50 cm beneath the ground surface) (lack of precise depth measurements due to the loss of the data). Drawing by A. Longa and K. Dzięgielewski

Fig. 9. Gdynia-Karwiny, site 1. 1 – position of the archaeological trench (left) in relation to the relics of artillery site (right), 2 – initial cleaning of trench 1 during the verificatory research in June 2014, 3 – level 3 after cleaning, July 2014 (view from the E). Photos K. Dzięgielewski (1, 3) and A. Longa (2)

illuvial horizon was recorded. The ceiling part of the alleged posthole was indistinguishable, probably blurred during the formation of the anthropogenic subsoil layer (arbitrary level 20–30 cm). All that was discovered in the posthole were a few small, natural gravel stones.

Feature 3 – pit connected with the deposition of the hoard and the alleged stone circle

The pit connected with the deposition of the hoard, situated slightly north of the trench's centre (Figs 7, 8) cannot be reliably described because it had been explored without

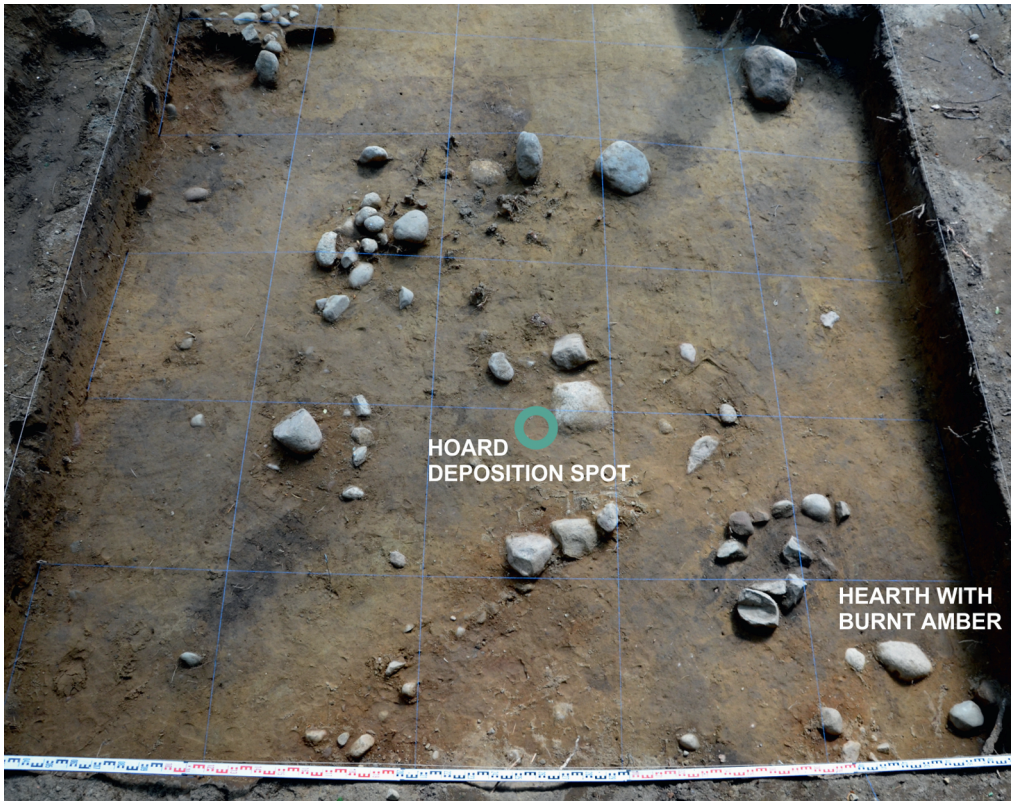

Fig. 10. Gdynia-Karwiny, site 1. Trench 1 during verificatory research in July 2014 (level 3, view from the N). Photo K. Dzięgielewski

documenting by the hoard's finder. Its position was identified during the verificatory research in June 2014. The pit was probably circular in plan and rectangular in section (cf. Figs 1C, 27: 1). However, during the verificatory research only the pit cut, without the original fill, could be recorded. It was 25 cm in diameter in the ceiling part, and the bottom was recorded at a depth of 58 cm. The bronze ornaments themselves, placed one atop another (in the following arrangement, from the bottom: ring no. 2, ring no. 1, bracelet no. 3 – Fig. 27: 1), reportedly filled the pit quite tightly. As revealed by the verificatory research, there were large and mid-sized erratic stones within a radius of approx. 2 m around the pit, perhaps in an arrangement roughly resembling a circle. The attempts to determine whether their arrangement was accidental (natural) or not produced no conclusive answer. Among the mentioned stones were some sizeable erratic boulders (up to 80 cm in diameter), which from the stratigraphic perspective should be seen as resting in a natural position (resulting from glacial activity). The same applies to stones of various sizes deposited within lenses of gravel, which in the explored part of the trench alternated with patches of sandy bedrock devoid of larger stones (Figs 8–10). On the other hand, there were other stones (e.g. within the subsoil layer) for which the stratigraphic context hints at their possibly intentional, or at least unnatural, arrangement (e.g. the first stone from the right in the cross-section in Fig. 11: 5). In general, however, one has to conclude that there are little grounds for claiming the presence of

Fig. 11. Gdynia-Karwiny, site 1. 1 – feature 1 (hearth) at level 3, view from the S, 2 – feature 1 (hearth), part N, at level 7 (90 cm), view from the S – lumps of amber visible (B), 3 – feature 1 (hearth), profile SW-NE, view from the SE, 4 – feature 2 (posthole?), profile W-E, view from the S, 5 – feature 3 (alleged stone circle), profile NW-SE, view from the SW. Photos K. Dzięgielewski

a deliberately built stone circle around the place where the hoard was buried. The most likely scenario seems to be the deposition of the hoard in a place marked by a natural concentration of stones on the surface (perhaps resembling a circle?), to which only single stones may have been added to complete the circle. The alleged stone circle is approx. 3 m in diameter, and the

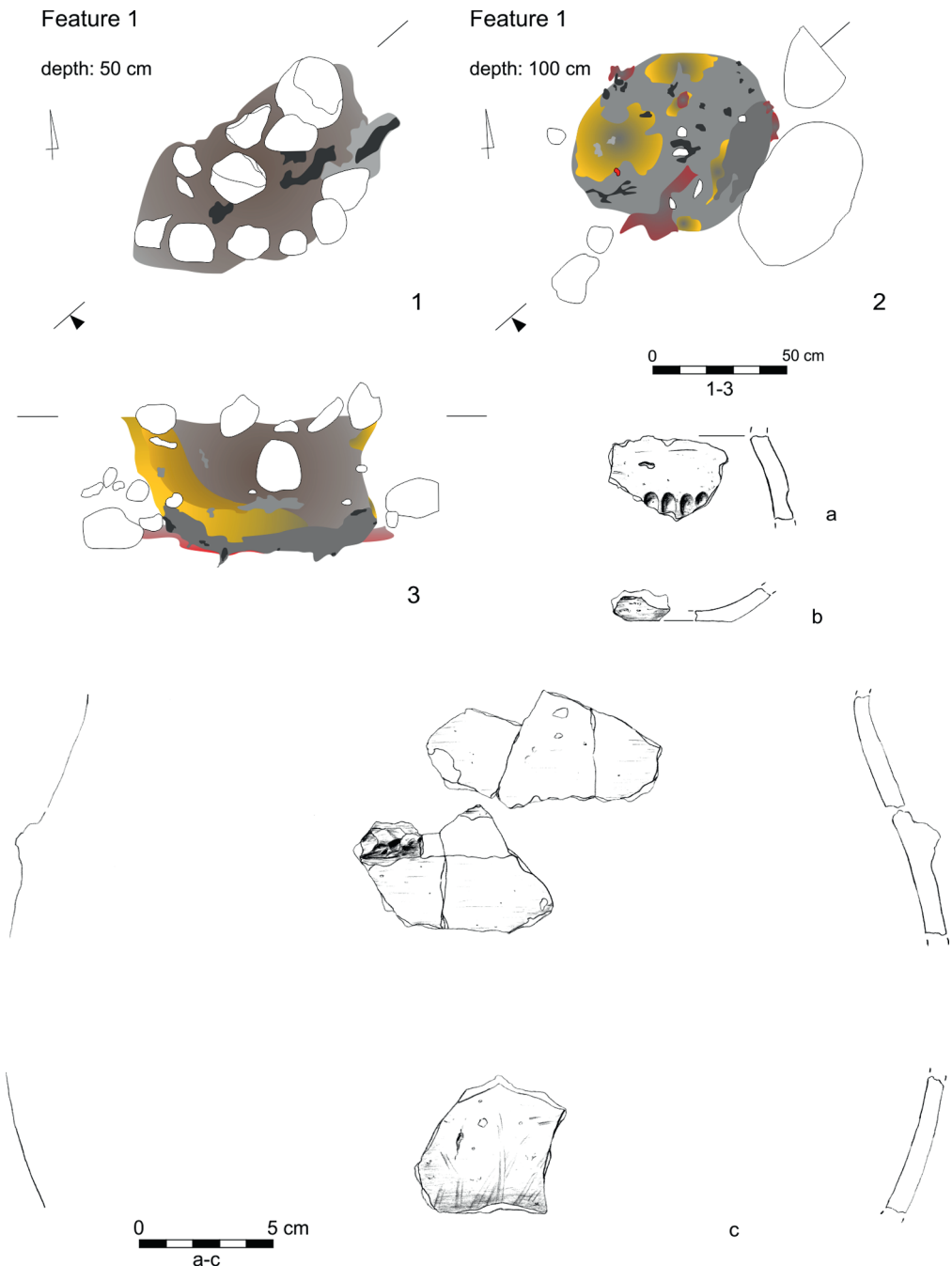

Fig. 12. Gdynia-Karwiny, site 1. Plan and profiles of feature 1 (hearth) and distinctive material from its fill. Drawings by K. Dzięgielewski

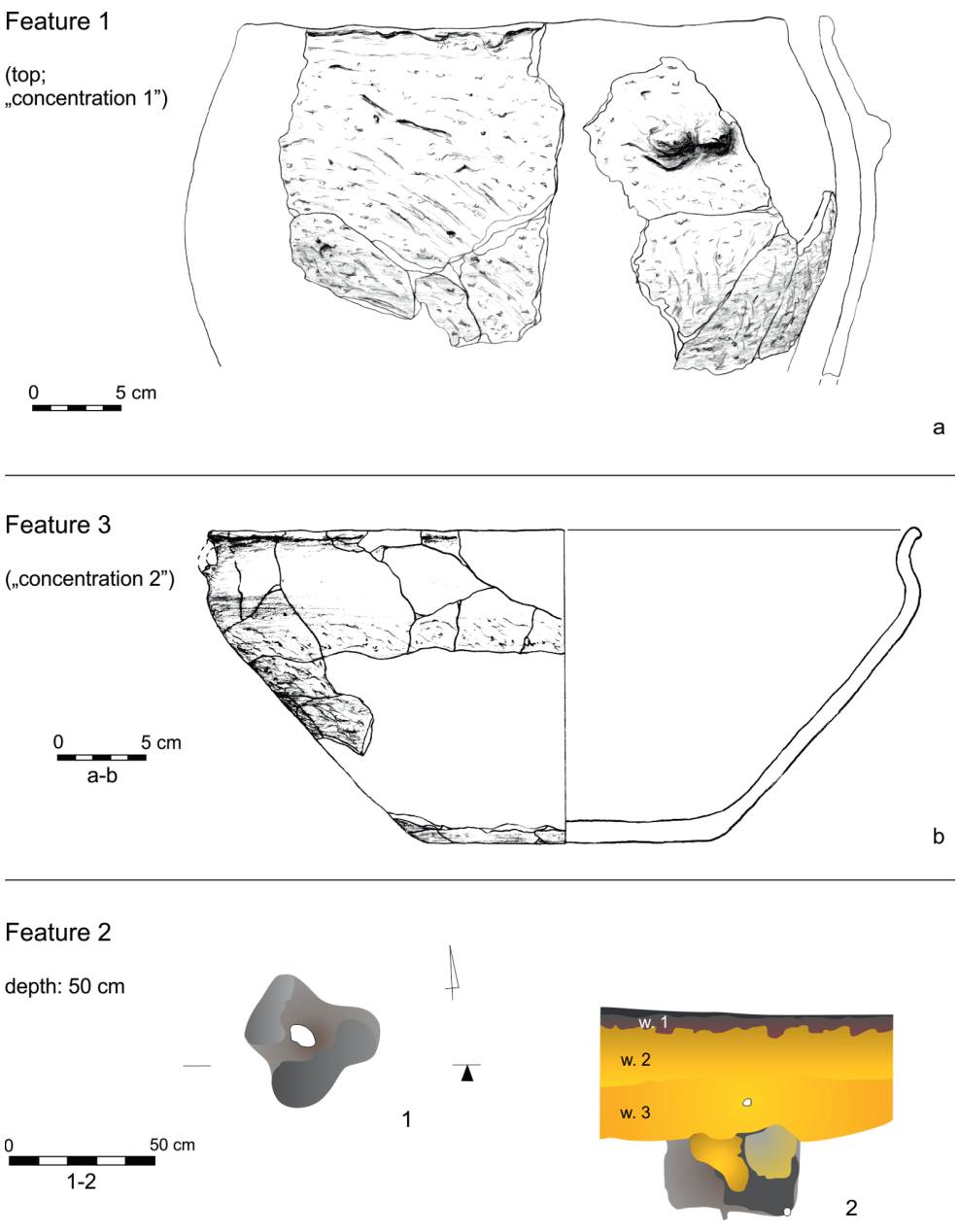

Fig. 13. Gdynia-Karwiny, site 1. Distinctive materials from the ceiling part of feature 1 ("concentration 1") and feature 3 ("concentration 2"), and plan and profile of feature 2 (posthole). Drawings by K. Dzięgielewski

Table 1. Gdynia-Karwiny, site 1. Field inventory (research of 2014)

INV. NO.	LOCATION	FEATURE	LEVEL	LAYER	PREHISTORIC POTTERY	MODERN-PERIOD POTTERY	OTHER ARTEFACTS	ARTEFACT TYPE/SAMPLE
1							1	bronze ankle ring (complete)
2							1	bronze ankle ring (damaged)
3							1	bronze bracelet
4	concentration 1	1	ceiling				2	lumps of amber
5	concentration 1	1	ceiling		31		1	flint
6			1–2		85		7	3 lumps of amber, 2 iron objects, 2 stones
7	from the surface		2		11			
8			2–3		21			
9	concentration 2				27			
10	trench 1, humus, spoil heap				9		1	cartridge case
11	trench 1, stray find		P1–P2		1			
12	trench 1, trench 2		P2–P3		10			
13	trench 2, forest litter		0-10 cm		0		1	flint
14	trench 2		P1		2			
15	trench 2		P1 do P2		16			
16	trench 2, stray find		P1–P2		2			
17		1	P3–P5	1 (humus)	14			
18	part W	1	P3–P8		14		2	amber, daub?
19		1	P7–P8	3 (bedrock)	6		1	amber
20		1	P8–P9		5			
21	spoil heap				4	4	1	iron object, modern-period
22	part W	1	P8–P9					soil sample
23		1	P7 do P8	3 (bedrock)				soil sample
24		1	P3 do P5	1 (humus)				soil sample
25	part W	1	P4–P7					soil sample
26	part N	2	P4–P5					soil sample
27	trench 1	1	P8–P9					charcoal
28		1	P7–P8					charcoal
29		1	P4–P6					charcoal

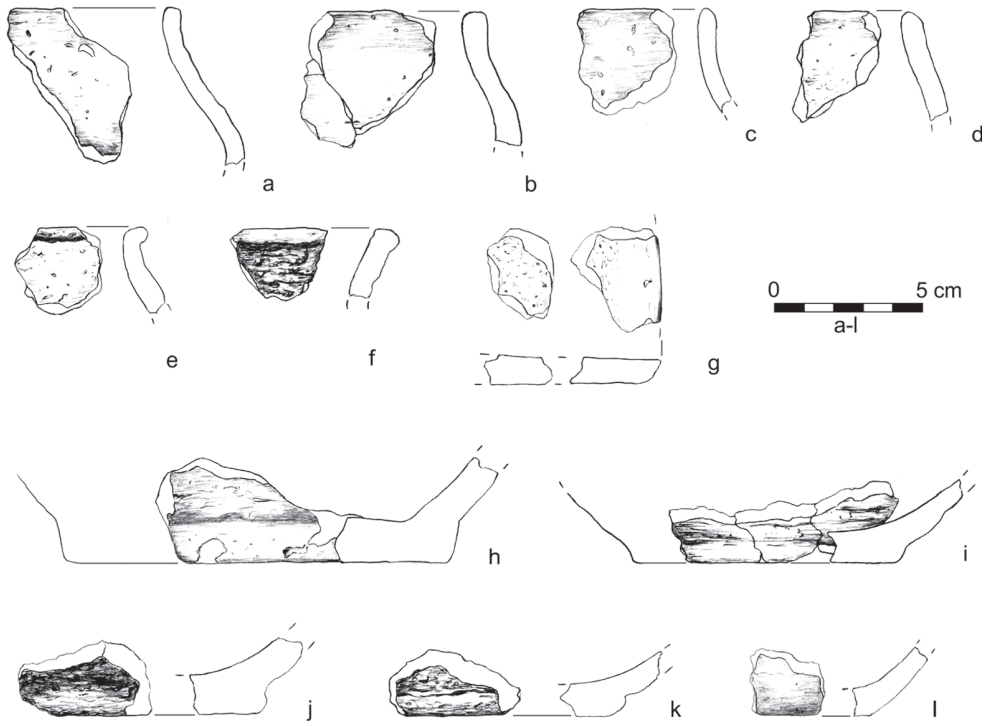

Fig. 14. Gdynia-Karwiny, site 1. Distinctive materials found outside the features. Drawings by K. Dzięgielewski

hoard was buried closer to its northern edge rather than in the centre. The hoard was buried near the largest of the boulders forming the concentration. However, it remains uncertain if this was a conscious choice, since the stone reached its full size (up to 80 cm in diameter) only at a depth of more than 60 cm, so it could probably not have been identifiable as the largest one at the time of the hoard's deposition (Fig. 11: 5).

4.3. Ceramic materials

The two research actions carried out in 2014 produced a total of 257 fragments, recovered from trenches 1 and 2. After reconstruction and technological analysis they were identified as originating from no more than 115 vessels ("ceramic units", table 1). Since the bulk of the potsherds (especially among the kitchen ware, see below) have very similar characteristics, the actual number of vessels represented in the explored part of the site can be supposed to be even smaller, perhaps not exceeding 50 vessels. Only 13% of the records (15 units) could be identified in terms of the vessel shape.

4.3.1. Formal-stylistic analysis

Among the formally identified vessels, the largest group are pots (6 pcs), although only one such vessel from feature 1 can be characterised in more detail. It is a large, egg-shaped pot, relatively well-preserved in the upper part, which was found in the ceiling part of the

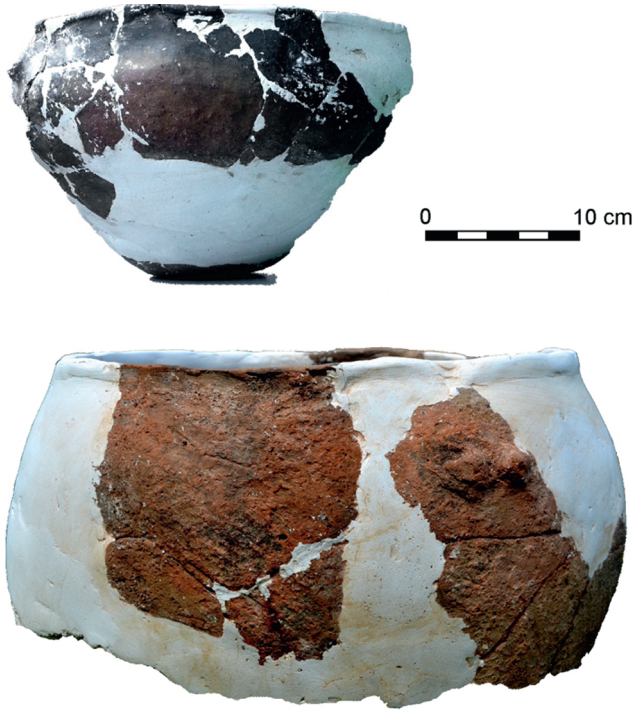

Fig. 15. Gdynia-Karwiny, site 1. Bowl from feature 3 („concentration 2") and pot from feature 1 ("concentration 1"). Photos by K. Dzięgielewski

hearth (Figs 13: b, 15: b). It was probably a storage vessel with the widest part of the body placed relatively high, with the walls tapering towards a flat bottom, and decorated with pairs of knobs below the rim. Such vessels, with their entire external surfaces deliberately coarsened, are known from Early Iron Age settlements in Eastern Pomerania, like Juszkowo, Dist. Gdańsk (Łuka 1966, fig. 1a–b; Podgórski 1972, fig. 4f; Fudziński, Ślusarska 2017, fig. 8a, 23a), Brzyno (Strobin, Molęda 2013, pl. III:4) and Gnieżdżewo in Puck District (Dziechciarz 2018, pl. IX:1, XXIX:6), and Gdańsk-Lipce, site 5 (Rembisz *et al.* 2010, fig. 3.19: 1), which developed during the Władysławowo phase (cf. Podgórski 1992; Dzięgielewski 2017, 300–305). Similar proportions (especially the "indentation" in the lower body) are also typical of pots which were sometimes used as urns or cloches in cemeteries of that period situated at the base of the Hel Peninsula. These vessels, however, were more often provided with handles rather than with knobs (cf. Petersen 1929, pl. 8e; Andrzejowska 2003, fig. 14a; 2004, fig. 16i). The remaining vessels identified as pots were only represented by small rim sherds (often with thickened rims) (Fig. 14: e, f). The best-preserved vase also originates from feature 1 (Fig. 12: c). In shape and decoration the vessel refers to biconical vases popular in Pomerania in the beginnings of the Iron Age, which had gently profiled shoulders often placed in the middle of the vessel's height, and slightly everted rim parts. These vessels were typically decorated at the shoulder (or slightly above) with a band of finger-tipped hollows (Andrzejowska 2003, fig. 25d, 27a, 36a, d; Pietrzak, Podgórski 2005, pl. XIV: 1, XXI: 1). Such a variant is possibly represented by another vessel from feature 1 (Fig. 12: a), while the best-preserved

vase mentioned above was instead decorated with a finger-tipped cordon in the upper part of the body (Fig. 13: c). Plastic cordons are highly characteristic – at least in cemeteries – for another group of vases: with a well-defined conical neck and bulbous body, where they separate the neck from the body (e.g. Andrzejowska 2003, fig. 37i; Pietrzak, Podgórski 2005, pl. VIII: 1). However, in a relatively large series of settlement pottery from Brzyno one can demonstrate examples of both biconical vases with plastic cordons at the shoulder and bulbous vases with the neck separated from the body by a line of hollows (Strobin, Molęda 2013, pl. V: 15, X: 6), which seems to indicate that in pottery of everyday use the manners of decoration (cordon below the neck and line of hollows at the shoulder) were not rigidly assigned to particular morphological or functional vessel types. Other vases in Gdynia-Karwiny were only identified based on characteristic, profiled upper parts with unthickened rims (Fig. 14: a–c). Most of these fragments must have belonged to biconical vases such as those discussed above. Among three vessels identified as likely bowls, of particular note is a large vessel recorded as "concentration 2" in the ceiling part of feature 3 (the structure connected with the hoard). This is a wide-mouth bowl with a profiled neck and outturned rim (Figs 13: b, 15: a). The rim is not as strongly outturned as in many bowls from the settlements at Juszkowo (Podgórski 1972, figs 9c, 11d, 12d, 14c; Fudziński, Ślusarska 2017, figs 9c, 18d, 22a, 28d, 35b, 44a, 52a, 74d), and Gdańsk-Lipce (Rembisz *et al.* 2010, figs 3.13: 1, 3.15: 2–6, 3.16: 2–3, 3.17: 4–5). On the other hand, vessels with less outturned rims can be found among the mentioned ceramic series from Brzyno (Strobin, Molęda 2013, pl. V: 8, V: 10–11, IX: 1) and Gnieżdżewo (Dziechciarz 2018, pl. XXVI: 2). If the observations made for bowls from other areas within the Lusatian complex can be regarded as valid for the southern Baltic coasts as well, then the profiled bowls in which the lip does not reach wider than the maximum body diameter should be dated later (to the Early Iron Age) than those with strongly outturned rims, typical of the Late Bronze Age (cf. Dzięgielewski *et al.* 2011, 326). This would indicate a slightly younger chronological position of the pottery from Gdynia-Karwiny and Brzyno within the Władysławowo phase (IIA2, i.e. HaC) relative to the mentioned materials from settlements situated to the south of Gdańsk (in the so-called Pruszcz Gdański cluster – cf. Dzięgielewski 2017, 302–304; Fudziński, Ślusarska 2017, 117). The last of the ceramic forms identified in the analysed material were flat discs-plates (3 pcs). They are all undecorated, and only one of them has the edge preserved (slightly cut downwards – Fig. 14: g). Such objects, whose function remains uncertain, were popular in Pomerania and in other areas inhabited by Lusatian culture communities at the close of the Bronze Age and throughout the Early Iron Age, which is reflected by them being commonplace finds in all the ceramic series mentioned here as analogies.

4.3.2. Technological analysis

The technology of manufacture of ceramic vessels was described based on analysis (of 115 ceramic units) which involved macroscopical determination of basic metric and technological parameters. "Raw" data are presented in Table 2. The development of the table and the analyses made use of the experience gathered by one of the authors, especially with respect to a pottery series – structurally akin to that from Gdynia-Karwiny – from a Pomeranian culture settlement at Hrubieszów (cf. Dzięgielewski 2013, 42–49, table 9). In the course of the analysis, the pottery was provisionally divided into two technological groups: "table" ware and "kitchen" ware (with 10 records designated as "group n" – undetermined). The necessity for such a division stemmed from the need to analyse the materials within the smallest groups possible – not only chronological, but also functional. This is because *en bloc* analysis of pottery collections seems to blur the factors responsible for the variatiability of particular attributes (see e.g. Muzolf 2002, 234–237).

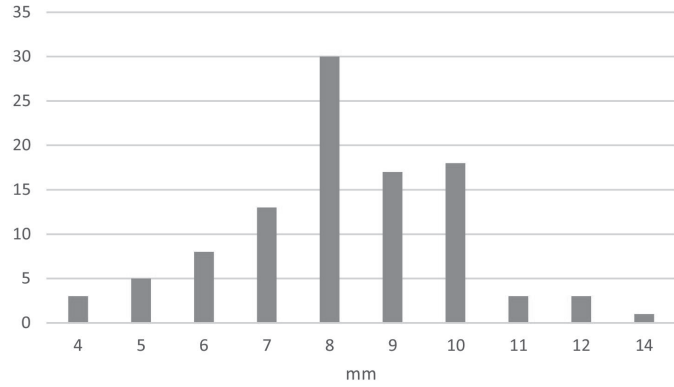

Fig. 16. Gdynia-Karwiny, site 1. Wall thickness of vessels dated to the Early Iron Age (n=115)

As mentioned in the context of vessel forms analysis, the ceramic material in question lacks stylistic criteria that would allow for distinguishing chronological phases. Therefore, the assemblage needs to be approached as a whole. In order to identify the actual technological diversity of the pottery, a decision was made to implement multivariate analysis. Apparently, only by taking into account correlations among many parameters associated with the technological aspects of clay mass preparation and firing is it possible to identify real (i.e. those that the potters were aware of) "technological groups". Among the methods suitable for this purpose is correspondence analysis, which was performed for the analysed materials based on frequencies of selected parameters from Table 2, such as wall thickness (Fig. 16), surface colour and texture, temper composition and density, wall section type, and vessel type.[10] After excluding some of the ceramic units (primarily delaminated and those representing "group n"), the analysis was performed on 105 records.[11]

The results of the correspondence analysis (Fig. 17) show that the intuitive distinction between "table" and "kitchen" pottery is well-grounded and that these are basically the only two "technological groups" distinguishable in this assemblage. However, it needs to be recalled that this division (attribute 9 from Table 2) was not included in the contingency table used in the analysis. After the results of the correspondence analysis were obtained, these intuitive

[10] The analysis was preceded by routine simplifications stemming from poor representation of certain attributes (e.g. the least common of the temper composition identified at the stage of pottery description were merged with other, similar ones). However, the original data are still presented in Table 2. The analysis was performed in the PAST statistical software (Hammer *et al.* 2001).

[11] Such a small numer of records may raise doubts with respect to the representativeness of the assemblage. As there is no good method of assessing the minimum size of a pottery collection suitable for statistical analyses (cf. Orton *et al.* 1993, 175), two control parameters were used in this purpose. In a representative assemblage the wall thickness distribution should be close to normal, and the ratio of rim and base sherds to body sherds should be more or less stable for formally similar pottery (Dzięgielewski 2013, 42). The first condition seems to be met for the Gdynia-Karwiny assemblage (Fig. 16), and the proportions of rims (8.6%), body sherds (83.6%), and bases (7.8%) are also similar to those recorded in pottery asssemblages of thousands of sherds of the Lusatian and Pomeranian cultures, e.g. from Łagiewniki site 5/7 in Greater Poland (respectively approx. 12, 84, 3% – Szamałek 1987, tab. 2), Sobiejuchy (approx. 15, 80, 4% – after Harding *et al.* 2004, tab. 5.8), or Markowice (approx. 9, 82, 6% – after Pawlak, Pawlak 2008, 192). Thus, despite its size, the pottery series from Gdynia-Karwiny as a whole seems to be a representative sample.

Table 2. Gdynia-Karwiny, site 1. Catalogue of Early Iron Age pottery (research of 2014)

Numeric designations: 1 – ceramic unit no.; **2** – field inventory no. (GKA1/...); **3** – trench; **4** – feature no.; **5** – depth (level 1 = 0 cm [after topsoil removal], 2 = 30 cm, 3 = 50 cm... etc.); **6** – layer no.; **7** – vessel part (a – rim; b – neck; c – upper body; d – belly max. protrusion; e – lower body; f – base part; g – base; h – handle; o – undetermined body rim; j – plate rim; k – inner part of plate); **8a** – max. wall thickness; **8b** – max. base/rim thickness; **9** – technological group (s – "table"; k – "kitchen"; n – undetermined); **10** – texture of outer and inner surfaces (1 – smooth; 2 – coarse; 3 – coarsened; e.g. 21/22 – coarse-smooth outside/coarse inside); **11** – colours of outer and inner surfaces (1 – black; 2 – grey; 3 – brown; 4 – yellow-grey; 5 – bright brick-red; 6 – brick-red; 7 – brick-red-grey; 8 – brown-grey; 9 – brown-brick-red; a – bright brick-red-grey; o – light grey; e.g. 12/22 – black-grey outside/grey inside); **12a** – number of colours in vessel wall section (1 – one-coloured; 2 – two-coloured; 3 – three-coloured); **12b** – colour boundaries in vessel wall section: o – sharp, p – average; ł – smooth); **13a** – temper compositions (temper types: 1 – fine-grained crushed stone up to 1 mm; 2 – fine-grained crushed stone up to 2 mm; 3 – mid- and thick-grained crushed stone up to 5

1 ID number	2 Cat. No.	3 Field cat. No.	4 Trench	5 Feature	5 Depth	6 Layer	7 Vessel part	8A Thickness (mm)	8B Base thickness (mm)	9 Technological group	10 Surface texture	11 Surface colour	12 Wall section type	12B Colour boundaries
1	9		trench 1, concentration 2	3			abcde-fgh	9	10	k	12/12	o2/o2	3	l
18	5		trench 1, concentration 1	1			abcde	10		k	33/11	59/59	3	p
19	5		trench 1, concentration 1				o	8		s	12/11	33/11	2	o
20	5		trench 1, concentration 1				o	7		k	33/11	55/99	3	l
21	7		trench 1, concentration on the surface				k	12		k	33/11	99/99	1	
22	7		trench 1, concentration on the surface				o	8		k	33/11	99/22	2	l
23	7		trench 1, concentration on the surface				abc	9		s	11/11	44/44	2	p
24	7		trench 1, concentration on the surface				abcd	6		s	11/11	99/88	3	l
25	7		trench 1, concentration on the surface				ef	9		k	33/12	39/88	2	p
26	6		trench 1		1-2		fg	11	15	k	32/11	55/99	2	l
27	6		trench 1		1-2		o	10		k	33/11	55/88	2	l
28	6		trench 1		1-2		o	8		k	33/11	55/88	2	l
29	6		trench 1		1-2		o	8		k	33/11	55/55	3	l
30	6		trench 1		1-2		jk		10	k	22/22	55/55	1	
31	6		trench 1		1-2		fg	8	12	k	32/22	44/44	3	l
32	6		trench 1		1-2		ab	8		k	32/11	89/88	3	p
33	6		trench 1		1-2		fg	10	11	k	33/11	55/22	2	l

mm; 4 – fine-grained crushed stone up to 2 mm and fine-grained sand up to 1 mm; 5 – fine-grained crushed stone up to 2 mm and sand up to 2 mm; 6 – thick-grained crushed stone up to 5 mm and sand up to 2 mm; 7 – fine-grained crushed stone up to 1 mm and fine-grained sand up to 1 mm); **13b** – temper density categories (1 – thin; 2 – average; 3 – dense; 5 – very dense); **14** – rim diameter; **15** – max. body diameter; **16** – height; **17** – base diam.; **18** – decorative motif (5 – finger-tipped hollows; 20 – cordon with nail-pinched hollows; 31 – double knob, horizontal); **19** – ceramic unit weight in g; **20a** – metric categories of particular sherds within a ceramic unit (1 – up to 1 cm²; 2 – 1–4 cm²; 3 – 4–16 cm²; 4 – 16–64 cm²; 5 – 64–144 cm²; 6 – above 144 cm²); **20b** – metric category of the entire ceramic unit; **20c** – number of sherds within a ceramic unit.; **21** – remarks (p – secondary burned; X1 – traces of joining coils with oblique ends; X2 – traces of joining coils by tongue and groove technique; X3 – traces of joining coils with straight ends); **22** – degree of erosion of ceramic unit (1 – ideally preserved or slight erosion, 2 – slight erosion (1 or 2 surfaces), 3 – strong (2 surfaces and edges)); **23** – vessel type (1 – plate; 2 – storage vessel; 3 – pot; 4 – vase; 5 – bowl); **24** – figure no.

13A Temper composition	13B Temper density	14 Rim diameter (cm)	15 Max. body diameter (cm)	16 Height (cm)	17 Base diameter (cm)	18 Decorative motif	19 Weight (g)	20A Metric category – sherds	20B Metric category – ceramic unit	20C Sherd number	21 Remarks	22 Erosion	23 Vessel type	24 Figure no.
3	3	40	40	17,5	16		ca. 5000	1,2,2,2,2,2,2,3,3,3,3,3,3,3,3,3,3,3,3,3,3,3,4,4,4,4,5	6	27	reconstructed with gypsum; total weight with gypsum!	2	5	13:b
3	3	31	39			31	515	2,2,2,2,2,2,3,3,3,3,3,3,3,3,3,3,3,4,4,4,4,4	6	52	reconstructed with gypsum; total weight with gypsum!; X3	3	2	13:a
4	3						5		2	1		2		
2	2						5		2	1		5		
6	3						10	2,2	3	2		3	1	
2	2						2		2	1		5		
5	3						18	2,3	3	2		2	4	14:b
2	4						22	3,3	4	2		3	4	14:a
2	3						43		4	1	residue on both surfaces; X3	2	3	
3	3				13		80		4	1		3	3	14:h
3	3						12	2,2	3	2		3		
5	2						13	2,3	3	2		3		
5	3						14		3	1		3		
5	4						19	2,3	3	2		5	1	14:g
6	3						23	3	3	1		5		
2	2						9		3	1		3	3	14:e
2	3						48	2,3,3	3	3		2	3	14:k

34	6		trench 1		1-2		o	10		k	33/11	55/11	2	p
35	6		trench 1		1-2		o	7		k	33/11	55/11	2	l
36	6		trench 1		1-2		o	8		k	32/11	55/88	2	o
37	6		trench 1		1-2		fg	10		k	33/11	55/88	2	l
38	6		trench 1		1-2		o	10		k	33/11	55/11	2	l
39	6		trench 1		1-2		o	9		s	11/11	88/88	3	l
40	6		trench 1		1-2		o	7		s	11/11	99/55	3	o
41	6		trench 1		1-2		o	9		n	32/11	44/44	3	l
42	6		trench 1		1-2		o	10		k	33/11	55/99	2	l
43	6		trench 1		1-2		o	8		k	33/11	55/22	2	l
44	6		trench 1		1-2		abc	9		k	23/11	88/99	2	l
45	6		trench 1		1-2		o	7		k	23/21	92/22	2	l
46	6		trench 1		1-2		o	10		k	33/11	55/11	2	o
47	6		trench 1		1-2		f	14		k	33/11	55/11	2	o
48	6		trench 1		1-2		ef	8		k	32/11	55/99	3	l
49	6		trench 1		1-2		o	8		k	33/11	55/22	2	l
50	6		trench 1		1-2		o	8		k	33/11	55/11	2	p
51	6		trench 1		1-2		de	7		s	11/11	aa/aa	1	
52	6		trench 1		1-2		o	10		k	23/21	55/22	2	p
53	6		trench 1		1-2		o	8		k	33/11	55/22	2	p
54	6		trench 1		1-2		o	8		k	23/11	55/22	2	l
55	6		trench 1		1-2		o	11		k	33/11	99/99	3	l
56	6		trench 1		1-2		o			n				
57	6		trench 1		1-2		o			k				
58	6		trench 1		1-2		o	10		k	33/11	88/11	2	l
59	6		trench 1		1-2		o	7		k	21/11	55/22	2	o
60	6		trench 1		1-2		o	6		n	32/11	66/22	2	l
61	6		trench 1		1-2		o	4		s	11/11	99/41	2	o
62	6		trench 1		1-2		o	8		k	33/11	55/22	2	p
63	6		trench 1		1-2		o	8		k	33/11			
64	6		trench 1		1-2		o	8		k	23/22	55/99	2	l
65	6		trench 1		1-2		o	6		s	12/11	55/11	2	l
66	6		trench 1		1-2		o	7		s	13/11	55/11	2	l
67	6		trench 1		1-2		o	10		k	33/11	55/11	2	p
68	6		trench 1		1-2		o	12		k	22/11	55/99	3	l
69	6		trench 1		1-2		o	9		k	33/11	55/99	3	l
70	6		trench 1		1-2		o	5		s	11/11	55/55	1	
71	6		trench 1		1-2		o	4		k	33/11	55/11	2	l
72	6		trench 1		1-2		o			n				
73	6		trench 1		1-2		o	8		k	22/22	aa/aa	1	
74	6		trench 1		1-2		o	10		k	33/11	55/11	2	o
75	6		trench 1		1-2		o	5		s	33/11	99/11	2	p
76	6		trench 1		1-2		o	5		s	11/11	11/33	2	l
77	6		trench 1		1-2		o	6		k	33/11	55/22	2	p
78	6		trench 1		1-2		o			n				
79	6		trench 1		1-2		o	8		k	33/11	44/55	2	o
80	6		trench 1		1-2		o	10		k	33/11	55/99	2	l
81	6		trench 1		1-2		o	10		k	11/11	99/11	2	l
82	6		trench 1		1-2		a	7		k	22/22	89/88	3	p
83	8		trench 1		2-3		fg	7	11	s	11/11	33/88	1	

3	3						25	1,2,2,3	4	4		3		
2	2						9		3	1		2		
2	2						10		3	1		1		
3	3						47	3,3	4	2		3	3	14:j
4	3						9		3	1	X2	3		
4	3						9		3	1	X1	2		
5	2						7		3	1		3		
2	3						12		3	1	X2	3		
3	2						8		3	1		5		
4	3						8		3	1		3		
2	3						9		3	1		2		
4	3						72	2,3,3,4	4	4		3		
3	2						13		3	1		2		
6	3						27		3	1		5		
4	2						59	3,3,4	4	3		3		
2	2						6		3	1		2		
5	3						11		3	1		5		
4	3						13		3	1		3	5	
5	3						11	2,3	3	2		5		
2	3						5		2	1		5		
3	3						5		2	1		3		
3	2						13	1,2,3	3	3		5		
							2		2	1		6		
							5		3	1		6		
3	3						11	2,3	3	2		3		
4	2						8		3	1		4		
2	2						4		2	1		3		
4	2						3	2,2	2	2		3		
3	3						5		2	1		3		
2	3						8		3	1	p, X2	5		
2	3						8		3	1		3		
2	2						4		2	1		3		
4	3						7	2,2,2	3	3		2		
3	3						5		3	1		3		
5	3						16		3	1		5		
3	3						17		3	1		3		
2	3						5		3	1		3		
4	3						9	1,2	3	2		5		
							2		2	1		5		
5	3						10		3	1		4		
5	3						6		3	1		3		
4	2						3	1,1	2	2		5		
2	2						1		2	1		3		
2	1						2		2	1		3		
							2		3	1		6		
5	2						2		2	1		5		
2	2						3		2	1		3		
3	3						7		3	1	X3	2		
2	2						3		3	1		3		
3	2				9		57	1,1,2,2,2,3,3,3,3,3	4	10	residue on both surfaces	3		14:i

84	8		trench 1		2-3		ef	9		k	23/11	89/11	2	l
85	8		trench 1		2-3		f	10		k	33/11	55/22	2	l
86	8		trench 1		2-3		o	10		k	33/11	55/11	2	l
87	8		trench 1		2-3		g		11	k	11/11	55/55	1	
88	8		trench 1		2-3		o	9		k	23/11	55/99	2	l
89	8		trench 1		2-3		o	5		s	11/11	88/11	3	l
90	10		humus and spoil heap				o	12		k	33/22	55/92	3	p
91	10		humus and spoil heap				fg	8	10	n	11/11	a9/22	2	p
92	10		humus and spoil heap				o	8		k	23/11	99/22	2	p
93	10		humus and spoil heap				o	9		k	33/11	55/aa	3	p
94	10		humus and spoil heap				o	6		s	11/11	81/22	2	p
95	10		humus and spoil heap				abc	6		n	11/11	88/88	3	l
96	10		humus and spoil heap				o	6		n	33/11	88/22	2	o
97	21		spoil heap				o	7		s	11/11	22/11	3	p
98	15	4	trench 2		1-2		o	9		k	33/11	55/aa	2	l
99	15	2	trench 2		1-2		o	8		k	33/11	59/22	2	p
100	15	3	trench 2		1-2		o	9		k	33/11	88/88	3	p
101	15	5	trench 2		1-2		o	9		k	33/11			
102	15	7	trench 2		1-2		k			k				
103	15	5	trench 2		1-2		o			k				
104	15	5	trench 2		1-2		o			n				
105	15	3	trench 2		1-2		o	8		k	33/11	88/22	3	o
106	15	1	trench 2		1-2		o	8		k	33/11	55/11	2	l
107	12	7	trench 1-2		2-3		o	8		k	33/11	55/88	3	l
108	12	4	trench 1-2		2-3		o	8		k	33/11	88/11	2	l
109	12	9	trench 1-2		2-3		o	10		k	33/11	55/aa	3	p
110	12	5	trench 1-2		2-3		o	9		k	23/22	55/99	3	l
111	12	1	trench 1-2		2-3		ab	9		k	33/11	55/55	3	p
112	12	9	trench 1-2		2-3		o	7		k	22/11	55/22	2	l
113	12	3	trench 1-2		2-3		o	10		k	33/11	82/11	2	p
114	12	6	trench 1-2		2-3		o			n				
115	13	1	trench 2		1		o	5		s	11/11	22/11	2	l
116	9	9	trench 1, concentration 2				o	9		k	22/11	55/22	3	l
117	11		trench 1, stray find		1-2		o	8		k	33/22			
118	16		trench 2, stray find		1-2		k	8		k	22/11	55/55	1	
119	16		trench 2, stray find		1-2		o	8		k	33/11	55/88	2	l
120	18		trench 1	1	3-8	1	bce	8		s	11/11	89/21	2	l
121	18		trench 1	1	3-8	1	o	7		s	11/11	99/98	3	o
122	18		trench 1	1	3-8	1	o	8		k	22/22	38/99	3	l
123	18		trench 1	1	3-8	1	o	11		k	12/22	55/22	2	l
124	20		trench 1	1	8-9	3	o			k				
125	20		trench 1	1	3-8	3	o	4		s	11/11	11/11	3	l
126	19		trench 1	1	7-8	3	g			k				
127	19		trench 1	1	7-8	3	o			k				
128	17		trench 1	1	3-5	1	o	7		k	33/11	55/22	2	l
129	17		trench 1	1	3-5	1	o	9		k	33/11	55/99	2	p
130	17		trench 1	1	3-5	1	fg	6	5	s	11/11	11/11	1	
131	17		trench 1	1	3-5	1	o			k				

2	3						55	3,4	4	2		2		
3	2						4	1,2	2	2		3		
2	3						14		3	1		3		
3	3						23	3,3	4	2		3		
2	3						10		3	1		3		
1	2						1		3	1		2		
6	3						24		3	1		5		
2	2						10		3	1		3		14:l
2	3						8		3	1		3		
5	3						2		2	1		4		
3	2						6		3	1		3		
2	2						10		3	1		3		14:c
2	3						2		2	1		4		
1	3						1	1,1	2	2		3		
2	3						14		3	1		3		
2	3						21	2,3	4	2		5		
5	3						6		3	1		3		
3	3						10		3	1	p	5		
							5	1,2,2	3	3		6		
							6	1,2	2	2		6		
							1	1,1	1	2		6		
2	2						4		2	1	X2	3		
5	3						3		3	1		2		
5	3						7		3	1	X2	3		
2	2						3		2	1		2		
6	3						12		3	1		2		
4	3						7		3	1		5		
2	2						8		3	1		2		14:f
2	3						6	2,2	2	2		3		
4	3						9		3	1		3		
							1		1	1		6		
1	2						1		2	1		3		
2	2						2		2	1	X2	5		
3	3						5		3	1	p	5		
5	4						13		3	1		3	1	
3	2						7		3	1		3		
2	3		24			20	137	1,2,2,2,2,3,3,3,3,3,3,3,3,4	5	14		2	4	12:c
2	2						19		4	1		2		
5	4					5	13		3	1		3		12:a
3	2						13		3	1		3		
2	2						7		3	1		6		
1	1						2		2	1		2		
5	2						6	2,3	3	2		6		
2	3						2		3	1		6		
2	2						6		3	1	X3	4		
2	2						8	1,1,2,2,2,3	3	6		6		
2	2						3		2	1		1	5	12:b
2	2						3	2,2	3	2		6		

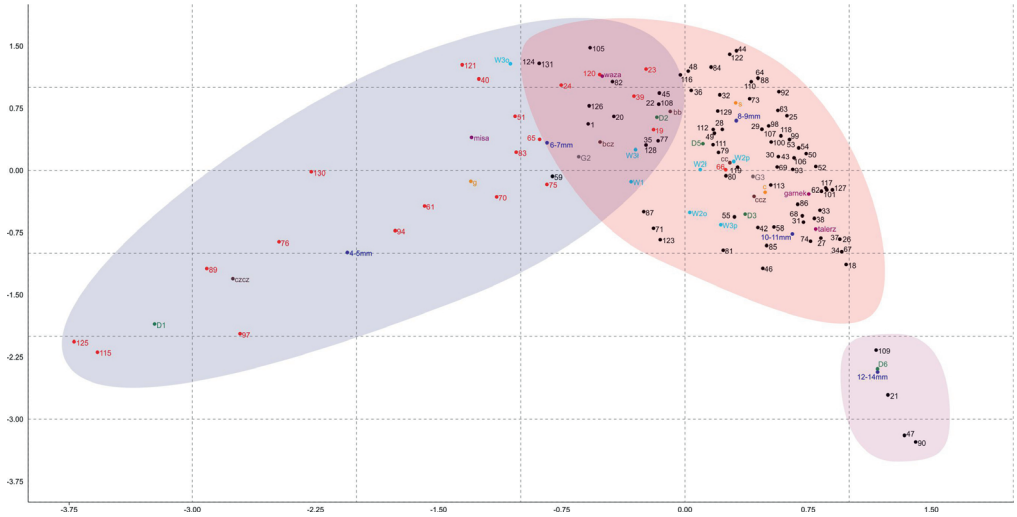

Fig. 17. Gdynia-Karwiny, site 1. Correspondence analysis of technological features of Early Iron Age pottery (axis 1 and 3). Pottery fragments (cases) arbitrarily assigned to "table ware" are marked with red colour, and those assigned to "kitchen ware" with black colour (this division was not included in the contingency table). Variables: dark blue – wall thickness, light blue – wall section type, yellow – surface texture, green – temper composition, maroon – vessel type (precise description in the text)

designations were plotted on the diagram to check if the groups had been correctly distinguished (red dots in Fig. 17). It turned out that the intuitive division overlapped quite well with the groups distinguished based on statistical methods (Fig. 17), as was also the case with the ceramic assemblage from Hrubieszów (Dzięgielewski 2013, 42, fig. 22: 2). An important conclusion drawn from the diagram is that it does not show any group concentrated around a single parameter, like temper type or surface texture, which are sometimes used as a basis for distinguishing technological groups in Bronze and Early Iron Age pottery. The third group that could perhaps be distinguished in the diagram can be described as the "technological group of storage vessels". This group, modest in size, can be distinguished based on only two criteria, namely thick-grained temper (D6) and thick walls (12–14 mm). When the criterion of wall thickness is excluded from the analysis (Fig. 18), this third group correlates to a much greater extent with the "kitchen" pottery. Thus, to distinguish it seems groundless, at least until the examined pottery series can be expanded.[12]

The analysis presented above allows for formulating general characteristics of the distinguished technological groups. They usually link with certain vessel types, which implies their functional nature. Pots, plates, and to a lesser extent vases link with "kitchen" pottery (Fig. 17). They are distinguished by thicker walls (from 7 to 14 mm thick), rough or coarsened surfaces, and dense temper added to the clay mass (G3 – 20–40% in the mass observed in freshly broken sherds). Pottery recipes D2, D3, D5, and D6 (the last one correlating more closely with "storage" vessels) predominant in this group are distinguished by mid- and thick-grained

[12] In a much larger series of Early Bronze Age pottery from Bruszczewo in Greater Poland the application of an analogical method confirmed that distinct technological procedures had been applied for the manufacture of thick-walled pottery (*Grobkeramik* – Kneisel *et al.* 2010, 133, figs 11–12).

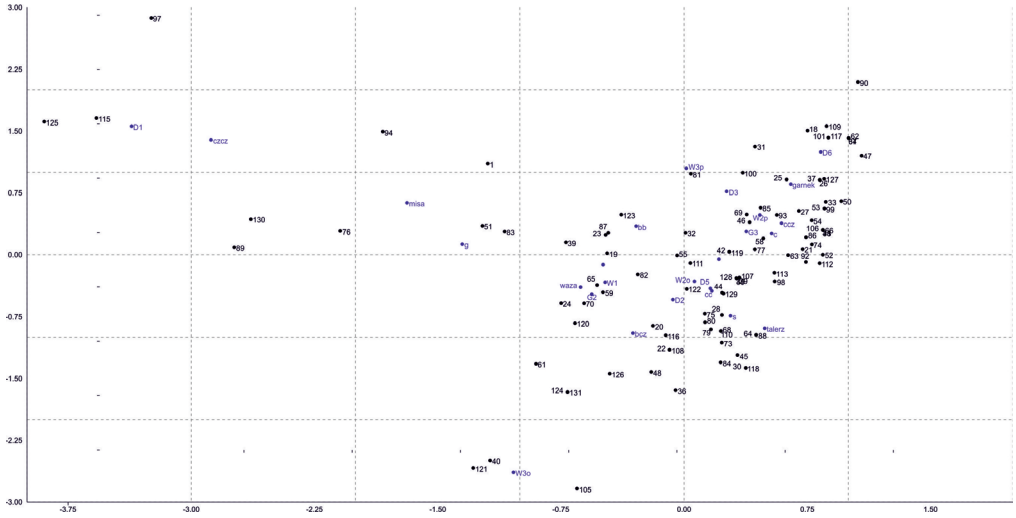

Fig. 18. Gdynia-Karwiny, site 1. Correspondence analysis of technological features of Early Iron Age pottery (axis 1 and 3) after exclusion of variables related to wall thickness

tempers (with grains of crushed granite 1–2 mm [D2] or above 2 mm [D3] in size, sometimes accompanied by sand grains 2 mm in size [D5, D6]). The vast majority of the kitchen pottery had red-brick (cc, ccz) or brown (bb, bcz) external surfaces, which may be indicative of the use of ferritic clays for their manufacture, and of firing in oxidising conditions. Dark-grey and dark inner surfaces (ccz, bcz) may confirm firing with limited oxygen access to the inside of the vessels (e.g. upturned vessels) or, probably less often, deliberate blackening of the surface. The low (14.5%) proportion of "mottled" surfaces among kitchen pottery is surprising, as they should prevail in vessels fired in hearths. This may stem from the considerable fragmentation of the analysed sherds (the smaller the fragments [under 10 cm^2] the smaller the chance to identify "mottled" surfaces – cf. Dzięgielewski 2010, 81, fig. 28), or it might indicate relatively good control over oxygen access, e.g. in sunken hearths (cf. Gibson, Woods 1997, 52–53). In the analysed group, leaving the surface unsmoothened (rough – 's' in the diagram) and coarsening the surface ('c') were by far the predominant variants of surface treatment.

As for the "table" pottery, only bowls and, to a lesser extent, vases link with this group (Fig. 17). The absence of such commonplace forms as jugs/cups or scoops undoubtedly stems from the small size of the series and its fragmentation. Among the attributes linked with this group are fine walls (4–6 mm thick), smoothened vessel walls on both sides ('g'), and intentional blackening ('czcz'). Vessels having brown outer surfaces and black inner surfaces ('bcz') occur slightly more often here than among kitchen pottery. Another important criterion associated with table ware is fine-grained granite temper, with grains below 1 mm (D1) or below 2 mm (D2) in size. In rare cases, recipes containing admixtures of sand (D5) were also recorded. Much more often than in kitchen ware the density of the temper was described as "average" (G2 – 10–20% in the mass observed in a freshly broken sherd). As in the series from Early Bronze Age Bruszczewo site, and from Hrubieszów, technological groups distinguished in the pottery assemblage from Gdynia-Karwiny differ above all in granulation rather than type of temper (Kneisel *et al.* 2010, 133, fig. 11; Dzięgielewski 2013, 44). Some ethnoarchaeological

accounts seem to suggest that only two recipes were used: one for vessels meant to be used for cooking and one for those meant for serving food (e.g. Rice 1987, 121).

The attribute connected with firing characteristics, the type of the fracture, correlates very loosely with the technological groups. In both groups, unicoloured sections (W1) indicative of firing long enough for all the carbon particles from the core of the sherd to completely oxidise, are relatively rare. Instead, two- and three-coloured sections prevail (W2, W3), dark inside, which are typical of pottery fired for insufficiently long time, usually in a hearth (Gibson, Woods 1997, 52–54). The predominance of W1 and W3 patterns in table ware is probably a derivative of wall thickness (in thinner walls organic matter burns out easier). The same can be said about a notable association between this technological group and wall sections with clearly marked transitions between layers of different colours (W3o). The sharpness of these boundaries depends on the pace of cooling after the firing, which was surely more rapid for thin-walled vessels. Kitchen ware, on the other hand, links with two-coloured sections (W2) with blurred boundaries between layers (W2ł, W2p), which stems from firing these vessels without access of oxygen to the inside (upturned vessels) and from slow cooling in a hearth. The general conclusion concerning the firing conditions must be as follows: the firing was performed similarily for vessels representing both technological groups (probably they were fired together), most likely in sunken hearths. The vessels were removed after slow, gradual cooling of the hearth. The only form of oxygen access control was by placing certain vessels with their bases up, and by using hearths which were (but perhaps not always) sunken into the ground.

Two of the attributes distinguished, namely vessel type and wall thickness, may raise doubts concerning their association with the narrowly understood technology of vessel manufacture. After removing the former attribute, available only for some records (15 cases – see Chapter 4.2.1), from the contingency table the diagram remains basically unchanged. More changes occur if we eliminate wall thickness, although this parameter cannot be seen as responsible for the shape of the diagram either. With the wall thickness criterion excluded, the division into "kitchen" and "table" groups remains evident, and the extent to which the groups overlap is similar (Fig. 18). What becomes blurred is only – as mentioned – the distinct position of "storage" pottery. Thus, this confirms the presence of two basic strictly technological groups and the lack of grounds for distinguishing any other groups. This conclusion is identical to that obtained for the slightly younger pottery assemblage of the Pomeranian culture from Hrubieszów (Dzięgielewski 2013, 44–45).

The obtained results are not immediately comparable with any other Early Iron age pottery series available from Eastern Pomerania. This stems primarily from relatively rare application of uniform procedures of pottery technology analysis. However, the few studies concerning the area of our interest in which these issues are addressed (cf. Dzięgielewski 2003, 94–95; Ignaczak 2011, 155–157; Piotrowska 2013, *passim*; Strobin, Molęda 2013, 237–238; Dziechciarz 2018, 66–69) suggest a "technological profile" of pottery from the turn of the Bronze and Early Iron Ages quite similar to the one described here.

4.3.3. Analysis of tarry substance on pottery fragments

A dark-coloured substance was noticed on the walls of two sherds from layers 2 and 2/3. The following samples were examined in the Laboratory for Materials Physicochemistry and Nanotechnology at the Faculty of Chemistry of Adam Mickiewicz University in Poznań:[13]
P11 – field inv. no. 7 (pottery fragm. no. 25; layer of tarry substance ~0.5 mm on the inner surface);

[13] The head of the laboratory and the author of the analysis is Professor Jerzy J. Langer, FRSC.

P11a – field inv. no. 7 (pottery fragm. no. 25; layer of tarry substance ~0.5 mm on the outer surface);
P12 – field inv. no. 8 (2 fragments of pottery (conjoining): large and small, no. 83; very thin layer of tarry substance <0.5 mm) on the inner surface);
P12a – field inv. no. 8 (2 fragments of pottery (conjoining): large and small, no. 83; very thin layer of tarry substance <0.5 mm) on the outer surface).

The methods applied included determining the melting point and the decomposition temperature (Kofler hot plate microscope Boetius PHMK), solubility and chemical reactivity analysis, FTIR spectrometry (Bruker FT-IR IFS 66/s), mass spectrometry coupled with gas chromatography GC MS (Varian 4000GC/MS), and observation under microscope (optical polarised light microscope, PZO). Samples P11 and P12 did not melt in temperatures below 300°C and did not undergo any noticeable changes, except for P11a where sublimation of a small amount of colourless substance was recorded at about 220°C. The examination revealed that the analysed materials are thermally degraded, and they do not dissolve or only partly dissolve in organic solvents such as methanol (MeOH), tetrahydrofuran (THF), acetonitrile (AN), chloroform ($CHCl_3$), benzene (C_6H_6), or in water and water solutions of H_2SO_4 (1M) acid and NaOH (1M) base. Such properties limited the scope of research, narrowing down the number of applicable methods.

Solubility (- none; +- partial)	H_2SO_4	NaOH	MeOH	THF	$CHCL_3$	AN	C_6H_6
P11	-	+-	-	+-	+-	-	-
P11a	-	+-	-	+-	+-	-	-
P12	-	+-	-	-	+-	-	-
P12a	-	+-	-	-	+-	-	-

Samples P11 and P11a originate respectively from the inner and outer surface of a vessel. In both cases the tarry substance sedimented on the ceramic surface as a thin (approx. 0.5 mm), heterogenous layer of dark colour (in places shiny and black, when observed under microscope). In samples P12 and P12a the layers were thinner or there were even no evident traces of tar (P12, large), and the layer covering the small sherd (P12, small) had a different structure and colour. Under the microscope, the free surface of tar suggests its low viscosity in contact with ceramics (liquid or semi-liquid material). FTIR spectral images confirm that the chemical composition was similar in samples from both vessles: this was an organic material with admixture of mineral components (mineral grains embedded in tar are visible in micrographs). The GC MS analysis detected the presence of retene, which is characteristic of tar made from coniferous wood (pine).

After its application on the ceramic surface the organic material (tar) suffered considerable thermal degradation, resulting in petrification. Micrographs reveal traces indicative of thermal decomposition – microcraters formed due to the escape of vapours and gases (Fig. 19). The layers on the outer surfaces of vessels (P11a and P12a) formed as a result of vapour condensation and accidental contact. These samples share similar traits, like an uneven thin layer of tar deposit with a developed free surface bearing traces of thermal decomposition (escape of vapours and gases), and embedded mineral crystals (larger in size than on the inner surfaces). The layers recorded on the inner surfaces (P11 and P12 small fragment), on the other hand, are remains of the vessel contents, which must have been liquid before they solidified.

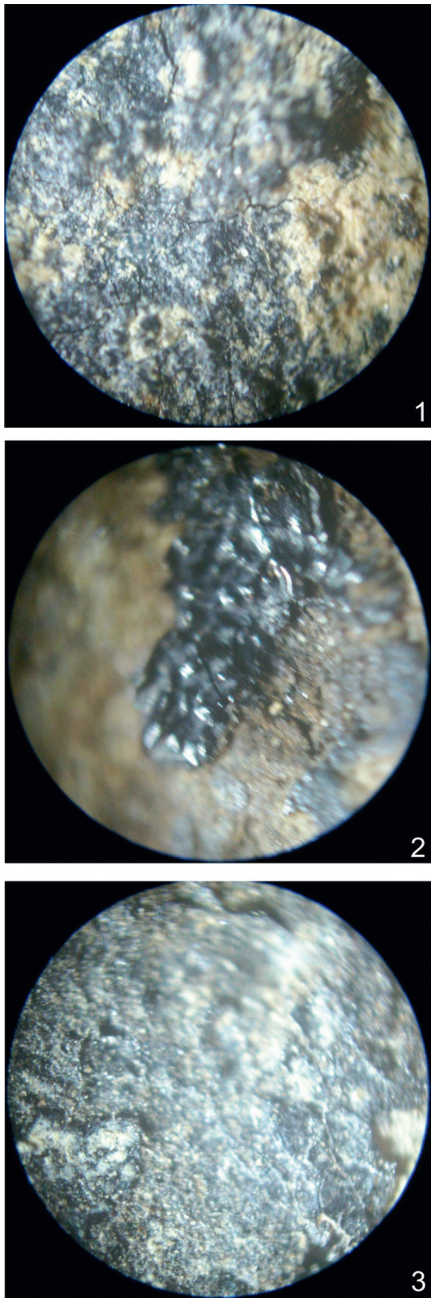

Fig. 19. Microscopic pictures (polarized light microscopy) of tar substance on pottery fragments: 1 – sample P11 (fragment no. 25, inner surface), 2 – sample P12a (fragment no. 83, large, outer surface), 3 – sample P12 (fragment no. 83, small, inner surface). Magnification 100×. Photos by J. J. Langer

In all the samples, the analysed substance bore clear marks of charred organic material with preserved CH_3 and CH_2 groups – the FTIR analysis revealed absosption at ~2950, 2920 and 2850 cm^{-1}, which is typical of these groups (Figs 20–22). Absorption at 3060 cm^{-1}, connected with the presence of C-H bonds in unsaturated aromatic structures which form due to thermal degradation (including retene, a compound diagnostic for coniferous tars), is poorly marked. Strong peaks observable in FTIR spectrograms around 1615 cm^{-1}, which represent asymmetrical oscillations of carboxylate group COO-, and around 1400 cm^{-1} (symmetrical oscillations of COO-), correspond to organic salts of carboxylic acids. A poorly marked line around 1700 cm^{-1} (oscillations of carboxyl group COOH) points to the presence of organic acids. Strong, continuous absorption within the range of 3600–1800 cm^{-1} is typical of thermally degraded (charred) organic matter. The similarity of FTIR spectrograms (Fig. 20), including the occurrence of diagnostic peaks at 880 cm^{-1} and 730 cm^{-1}, confirms that all the samples had similar composition and origins (coniferous tar). This conclusion can be further refined by comparing the results with the spectra of Baltic amber samples (Matuszewska 2009, fig. 1; 2012; 2016; Mendyk 2012). One can notice a distinct similarity of absorption patterns within the "dactiloscopic range" of 1000–1300 cm^{-1} (including the occurrence of characteristic "Baltic shoulder" at 1200–1250 cm^{-1}) (Fig. 21), absorption of acidic groups COOH at 1700 cm^{-1}, CH_2 and CH_3 at 1452 cm^{-1}, 1383 cm^{-1}, and 2850–2950 cm^{-1}, and O-H at 3430 cm^{-1}. It is therefore possible that the tarry layers formed as a result of thermal decomposition of Baltic amber or involving Baltic amber.

Absorption within 1025–1030 cm^{-1} (with maximum intensity different in samples P11-P12) corresponds to the presence of C-O bonds but also – together with the peak around 465 cm^{-1} – correlates significantly with differences in the contents of mineral

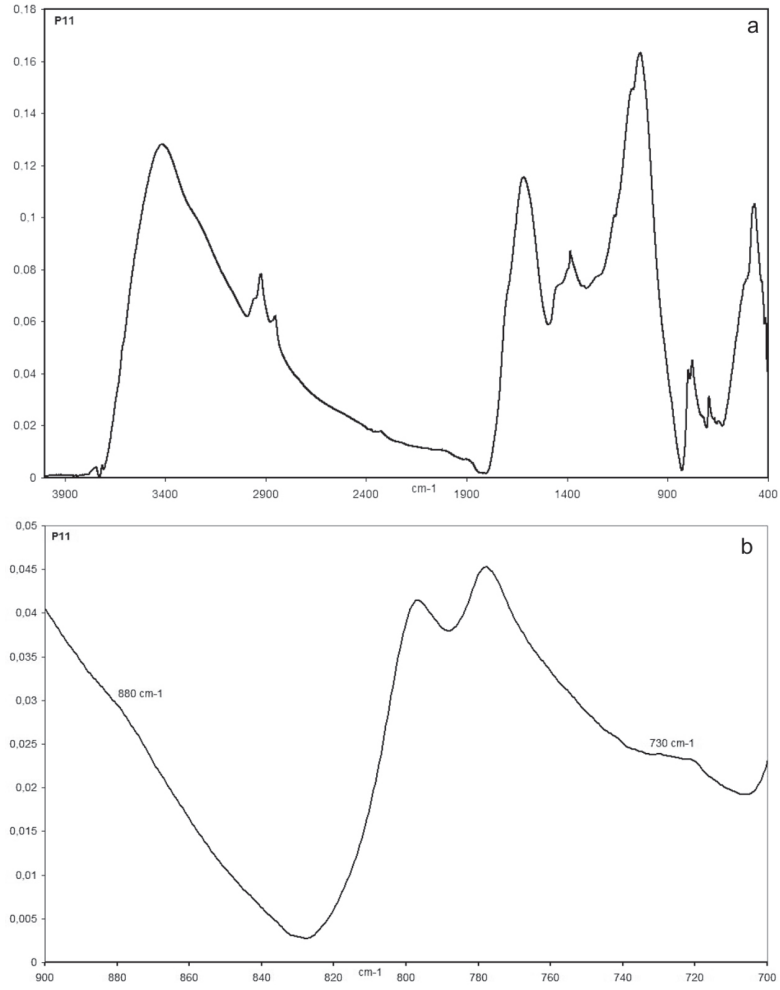

Fig. 20. Infrared spectra (FTIR) of tar substance in sample P11 (fragment no. 25, inner surface)

substances (like phosphates, sulphates, SiO_2 and derivatives), which was the highest in P12. The lines with maxima at 798 cm^{-1} and 778 cm^{-1} reveal the presence of quartz. Mineral grains embedded in organic matter (tar) are also detectable in micrographs.

GC MS analysis of choloforme extracts of samples P11, P11a, and P12 revealed complex chemical compositions, which were close in terms of components but differed in their proportions. Contemporary contaminations prevail (dimethyl phthalate, butyl phthalate). In sample P11 (and P11a) the GC MS analysis identified the presence of retene (234 m/z), which is a product of thermal degeneration of coniferous tree components (e.g. it occurs in tar produced by means of dry distillation of pine wood). No components diagnostic of birch wood tar (e.g. betuline) were identified (Figs 23–24). This corroborates the results obtained by FTIR.

The traits shared by all the analysed samples include resistance to high temperature, limited or no solubility, similar, characteristic infrared spectra (FTIR), differing from those of typical wood tars (birch or pine), with the dominant absorption of carboxylate anions COO- with

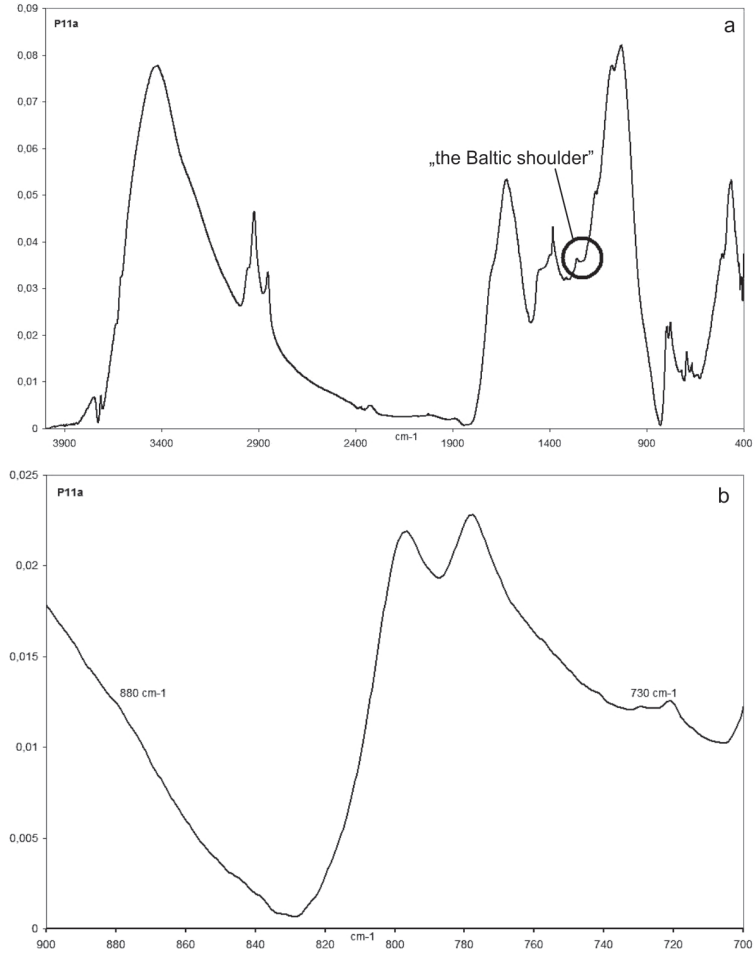

Fig. 21. Infrared spectra (FTIR) of tar substance in sample P11a (fragment no. 25, outer surface)

poorer absorption of carboxyl acids COOH. This is indicative of thermal degradation of organic matter. Also observed are strong bands linked with popular mineral substances (around 100 cm^{-1} and within the 450–800 cm^{-1} range), including silica, silicates, carbonates, sulphates, and phosphates. Mineral components could be intentional additions meant to modify the tar (P11, P12-small), or natural contamination originating from soil. As shown by microscopic examinations, the tar from inside the vessels contain embedded mineral substances with grains of similar, small sizes, which may suggest their intentional addition. The samples from outer surfaces (P11a, P12a) contain mainly accidental contaminations, with larger grains diversified in size, partly embedded in the tar.

Summing up, the samples contain charred organic material which originally occurred in liquid or semi-liquid form. This is not a typical wood tar (birch or pine) in a pure form, although physico-chemical properties of the material show affinity to coniferous tar. Thus, it is possible that Baltic amber was used – either as the original material or one of its components. Tiny pieces of thermally processed amber were recorded in hearth 1 near the place where the examined

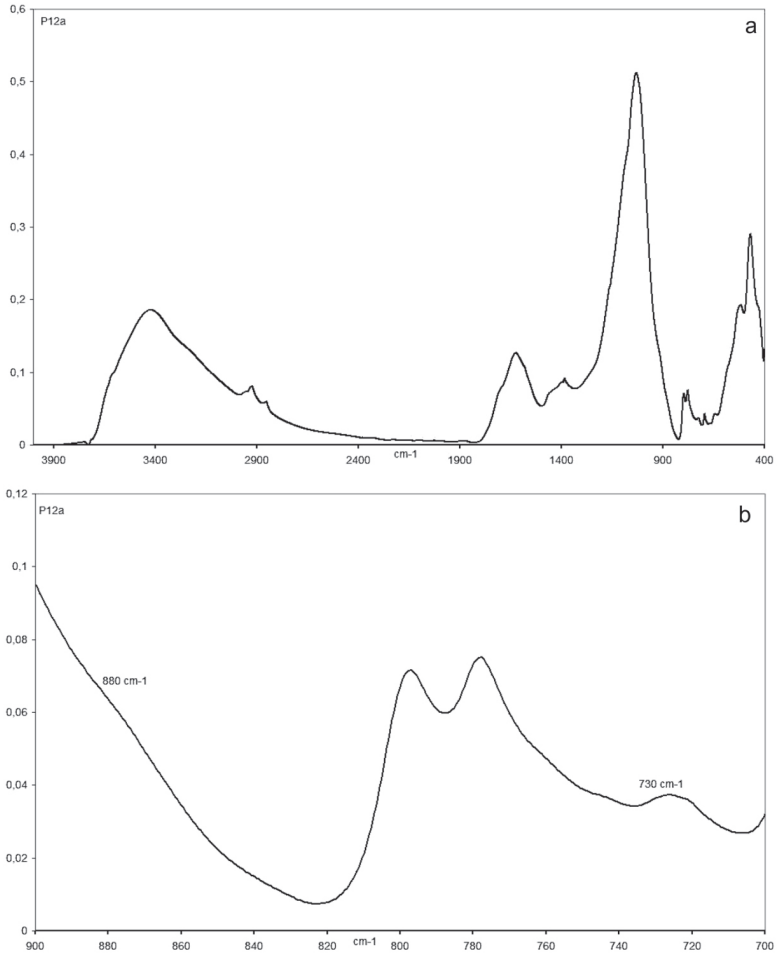

Fig. 22. Infrared spectra (FTIR) of tar substance in sample P12a (fragment no. 83, outer surface)

potsherds were found (see below). The organic material in samples from inside of the vessels contained fine-grained mineral components, possibly indicative of deliberate modification of the material's properties already at the stage of its production or preparation in liquid form.

4.4. Amber

Lumps of unworked, partly crushed amber were found loosely within layer 2 (inv. no. 6) and in the fill of feature 1 (hearth), where they were found both in the ceiling (concentration 1 – inv. no. 4) and bottom parts (inv. nos 18, 19). Altogether, 8 lumps of reddish succinite were found, of different sizes (up to 2.5 cm), with partly matt and eroded surfaces, which at least to some degree stems from exposure to high temperature.[14] The lumps do not bear any traces of processing.

[14] The erosion and colour of the lumps has been interpeted in this manner by Professor B. Kosmowska-Ceranowicz, whom we would like to thank here for consultation.

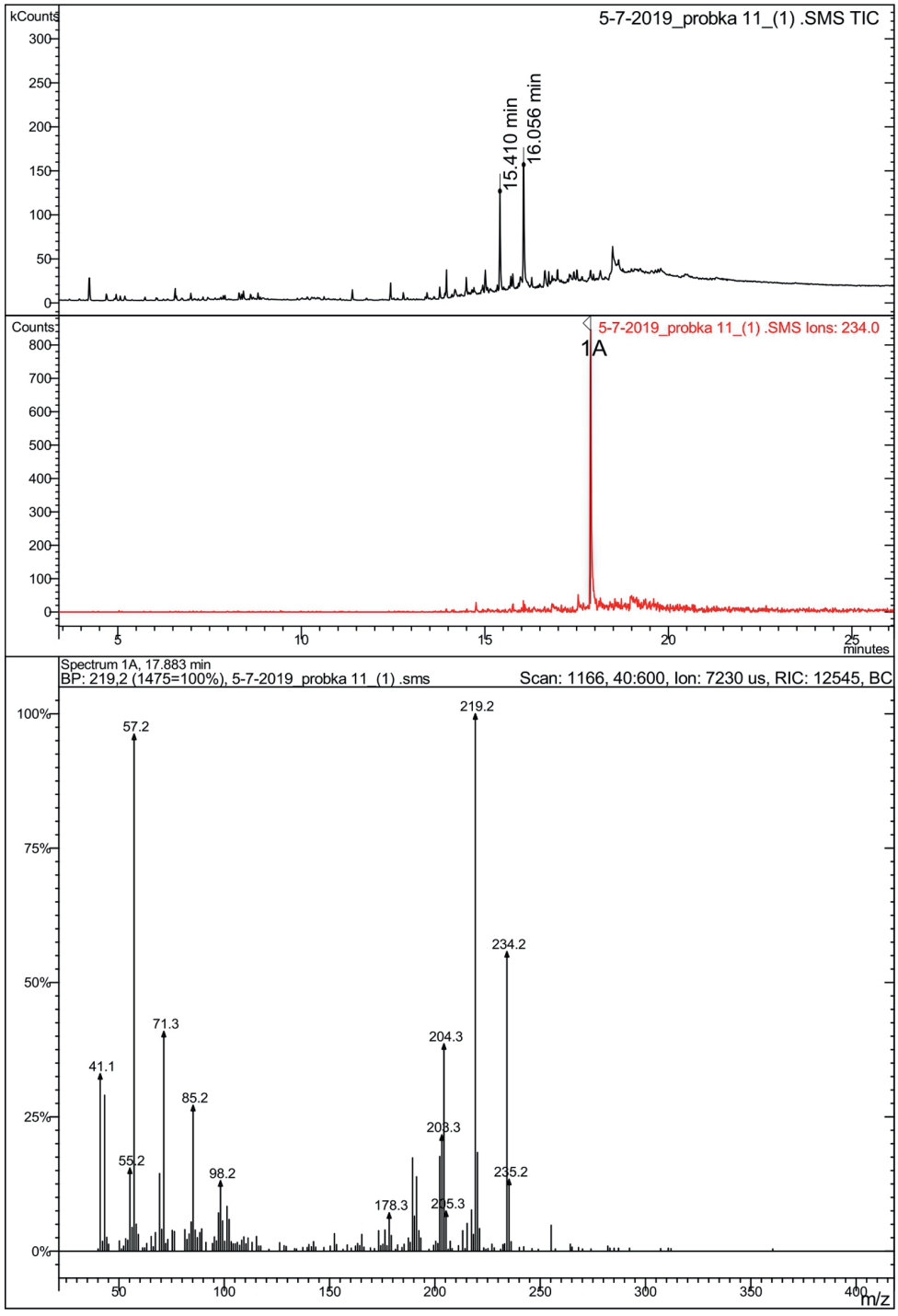

Fig. 23. Mass chromatogram and mass spectra (GC MS) of tar substance in sample P11 (fragment no. 25, inner surface)

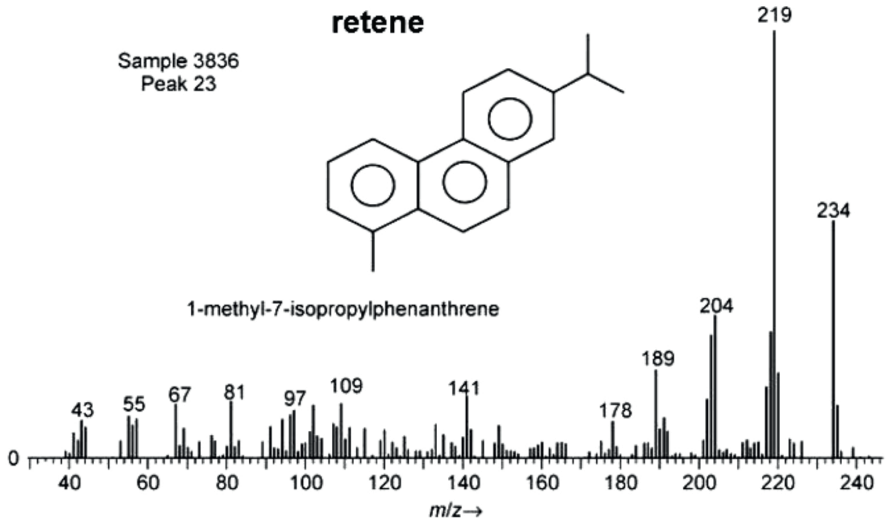

Fig. 24. Mass spectrum (GC MS) of tar substance in sample P11 (fragment no. 25, inner surface)

4.5. Contemporary materials

A few traces of contemporary and modern period human activity were recorded within the investigated area. They include the remains of a German artillery position from 1945, mentioned at the beginning, with which possibly link two pieces of military equipment: an undetermined wedge-shaped iron object, quadrangular in section and with concave sides (Fig. 25: d) and a brass rifle case from a Mauser-type rifle (Fig. 25: e).[15] The remaining contemporary objects were a hand-wrought iron nail (Fig. 25: c), a fragment of a ceramic roof-tile or drain pipe, and 4 fragments of wheel-made ceramic vessels. Two of the latter have traces of olivegreen-white enamel on their inner surfaces (Fig. 25: a–b). Although both the nail and the pottery can be dated to the 19th – first half of the 20th century, linking them undoubtedly with the military episode from WWII would not be justified, as these artefacts may have found their way to the place accidentally at some other time.

4.6. Anthracological and paleobotanical analysis

During the excavations, soil samples containing tiny pieces of charcoal were collected, and they were later subjected to anthracological examination.[16] Charcoal surviving in archaeological sites can provide information of paleoethnographic and paleoenvironmental nature (Chabal 1997; Lityńska-Zając, Wasylikowa 2005). Given the small number of samples, the

[15] Thanks to clearly legible designations (P S* 16 38) it was possible to conclude that the cartridge was made from brass (with 72% copper and 28% zinc in the alloy) by Polte Armaturen und Maschinenfabrik A.G. Zentrale Magdeburg in Saxony in 1938, series number 16 (based on https://dobroni.pl/n/znakowanie-skrzyn/19217, access date 16.08.2017).

[16] The analysis was performed in the Władysław Szafer Institute of Botany, Polish Academy of Sciences, in Kraków.

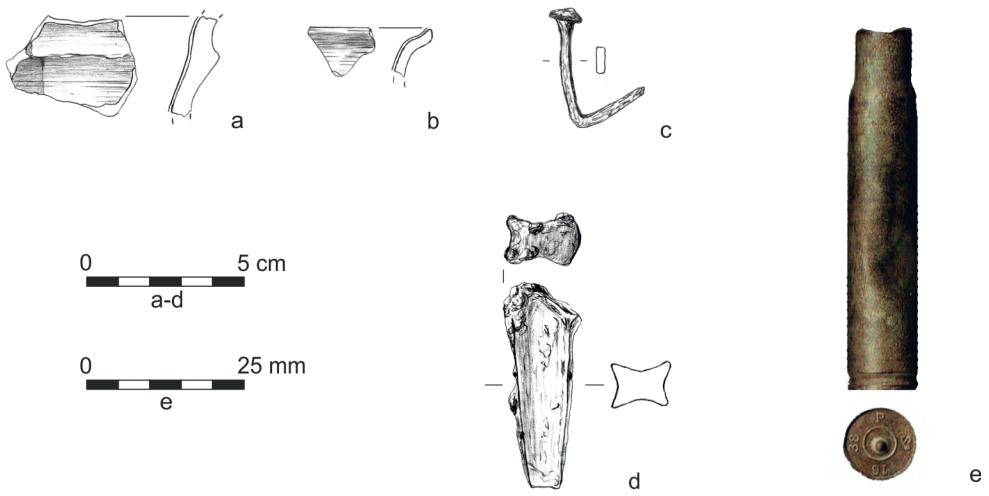

Fig. 25. Gdynia-Karwiny, site 1. Modern period artefacts (a–b – pottery, c–d – iron, e – brass). Drawings and photos K. Dzięgielewski

material from Gdynia-Karwiny can possibly provide mainly paleoethnographic information concerning tree species whose wood was used in the hearth. Charcoal analysis involves taxonomic identification of individual fragments, and determination of origin and condition of wood prior to its burning[17] (e.g. branch wood, decayed wood). Firewood is usually distinguished by taxonomic diversity, since easily available material was typically collected for this purpose (Chabal 1997; Lityńska-Zając, Wasylikowa 2005). In addition, charcoal from firewood often bears traces of activity of funghi and wood-eating insects, indicative of gathering and burning dead wood, possibly brushwood (Moskal-del Hoyo *et al.* 2010). The results of the anthracological analysis are presented in the table below:

Taxon \ Sample	Feature 1, depth P8-P9, inv. no. 22	Feature 1, depth P7-P8, inv. no. 23	Feature 1, depth P3-P5, inv. no. 24	Feature 2, depth P4-P5, inv. no. 26
Carpinus betulus	1	12		
Pinus sylvestris				46
Betula sp.		2		
Quercus sp.	68	47	40	

[17] Determination of charcoal fragments is done by observation of freshly broken pieces along three anatomical planes: transversal, axial-radial, and axial-tangential. Charcoal pieces have been determined using a metallographic microscope with magnifications ranging from 100 to 500 times, and by using anatomical atlases (Schweingruber 1982; 1990) and the comparative collection kept at the Department of Paleobotany of the W. Szafer Institute of Botany in Kraków. The results of taxonomic determinations (e.g. species, genus, family) are affected by the size of charcoal fragments, state of their preservation, and anatomical characteristics (Schweingruber 1990; Lityńska-Zając, Wasylikowa 2005). In Europe, wood is typically determined to the level of genus, while species names are given when a certain genus is only represented in the local flora by one species (Lityńska-Zając, Wasylikowa 2005).

Tilia sp.			3	
deciduous	1	3	4	2
coniferous				2
Total number of fragments	**70**	**64**	**47**	**50**
branches		1x	1x	2x
Funghi and wood-eating insects		2x	1x	3x

The samples originated from the ceiling (P3–P5) and bottom layers (P7–P8, P8–P9) of hearth 1 and from the ceiling layer of feature 2 (P4–P5). Among the charcoals from feature 1, 181 fragments were taxonomically identified, and 50 fragments from feature 2. In samples P7–P8 and P3–P5 all fragments were identified. In the remaining samples only some of the fragments were identified, because the identified taxa (2 taxa identified to the level of species in sample P8–P9 and 1 taxon identified to the level of species in sample P4–P5) appeared in the first 10 fragments analysed, and subsequent analyses did not add to the list. Only deciduous species were identified in the hearth, with a marked prevalence of oak (*Quercus* sp.), whereas in pit 2 (posthole?), where generally less macroscopically discernible charcoals were found and which was not a place where wood was burned *in situ*, charcoals originating almost exclusively from coniferous species were recorded, with the prevalence of Scots pine (*Pinus sylvestris*). It seems that only the charcoal from the hearth can be regarded as the basis for identifying main species of firewood, which means available in the immediate vicinity of the site. It is only this feature that, due to the discovery of ceramic chronological indicators and the conjoining of sherds with those found in the cultural layer and in "concentration 2" (i.e. feature 3), can be connected with the moment of the hoard's deposition (feature 2 can potentially have no chronological connection with the analysed assemblage). The taxonomical composition of the charcoal from hearth 1 refers to the few analysed series from settlements in Eastern Pomerania (cf. Stępnik 2011), and it seems to reflect the species composition of nearby tree communities. The prevalence of thermophilic deciduous tree species in these communities fully agrees with the palynological findings, which suggest that as late as in the beginnings of the 1st millennium BC vast areas on the shores of the Bay of Gdańsk were still covered with primeval, mainly deciduous, forests, which had not yet been significantly transformed by humans and where the prevalent species were oak, elm, linden, and ash, with hazel in the undergrowth (Latałowa 1997, 114–116). The occurrence of multi-species deciduous forests in that period is also corroborated by the potential natural vegetation map, with the site situated within the range of *Stellario-Carpinetum* forests (Matuszkiewicz 2008, map sheet A2). Furthermore, such a picture agrees with reconstructions that suggest that a larger-scale settlement expansion, affecting the species composition of forests in this part of Pomerania, did not take place before the Władysławowo (IIA) phase (cf. Dzięgielewski 2017, 302, 313). The materials discussed here can be seen as a modest affirmation of this process.

In addition, a single charred caryopsis of common barley (*Hordeum vulgare*) was identified in hearth 1 in the sample collected from level P7–P8. This cereal species was one of the most important cultivates during the period of economic (mainly agricultural) boom observed in Eastern Pomerania at the dawn of the Early Iron Age (in the Władysławowo phase) (cf. Rembisz *et al.* 2010, 83–84; Dzięgielewski 2017, 313). In this context, it is worth recalling the well-known example of the pit from Juszkowo, filled with charred barley grains (Klichowska 1979).

5. Chronology of the hoard and site

The dating of the uncovered assemblage can be undertaken on three independent grounds: (1) stylistic dating of the bronzes and the statistical contextualisation of the entire hoard based on the data presented recently for a series of hoards from Pomerania (Dzięgielewski 2017, fig. 2; in preparation); (2) stylistic dating of pottery; (3) radiocarbon dating of the charcoal from the fill of hearth 1. The most precise results can be obtained with the stylistic analysis of the hoard, which was comprised of hollow ankle rings of the Reda-Rekowo type and a late kidney bracelet of the Gniewino type. Both these morphotypes occur in Pomerania within a relatively narrow period spanning the close of sub-phase HaC1 (HaC1b) and the beginning of sub-phase HaC2 (HaC2a), which falls between ca. 750 and 650 BC on the absolute timescale (cf. Trachsel 2004, fig. 195; Dzięgielewski 2017, fig. 2). The stylistic dating of ceramic vessels is naturally much less precise. Nevertheless, references to pottery series from such sites as Juszkowo and in particular Brzyno indicate that it does not contradict the chronology proposed above. The same can be said about the radiocarbon age determination obtained for the oak charcoal collected from feature 1. Of the two conventional ^{14}C dates obtained, one has been interpreted as relevant (not rejuvenated) (Fig. 26). Date MKL-2318: 2500±60, falling within 794–430 BC (2σ range) or 776–541 BC (1σ range), falls precisely in the Hallstatt plateau on the calibration curve (Fig. 26:a), which does not contradict the chronology proposed on stylistic grounds, but – unfortunately – does not make it any more precise either (the 1σ range perhaps points to the 8th–7th centuries BC).

6. Broader context of the find

The section of the Kacza Valley of our interest, cutting into the eastern margin of the Kashubian Lake District, has not previously produced any materials attributable to the Lusatian or Pomeranian cultures. However, the Gdynia region in the broader understanding, as well as the entire marginal zone at the boundary of the Pobrzeże Kaszubskie and the Kashubian Lake District plateau (cf. Kondracki 1978, 273–274), abounds in remains of human settlement from the turn of the Bronze and Early Iron Ages (Łuka 1966, 115–128; Dzięgielewski 2005; archives of the Gdańsk Archaeological Museum). Marked by complex relief, the zone of erosional valleys which opened on the narrow coastal strip near what today are the Wielki Kack, Karwiny, Mały Kack, and Witomino districts of Gdynia was intensively infiltrated at that time. The only bronze hoard known from this area was discovered in 1892 during agricultural works, in marshy soil on the shores of former Wielkokackie Lake in Gdynia-Wielki Kack (Sprockhoff 1956, 26). The hoard was comprised of a necklace, bracelets, elements of a string of bronze beads, and 4 swallow's tail-shaped pendants along with one bell-shaped pendant – parts of horse harness jingle plates. The assemblage can be linked with the turn of the Bronze and Early Iron Ages, although its composition cannot be seen as standard (cf. Sprockhoff 1956, *passim*). The majority of sites known from the discussed region are flat cemeteries with burials in stone boxes (Gdynia-Mały Kack, sites 1, 2, 3, Gdynia-Wielki Kack, sites 1, 2, Gdynia-Witomino, site 1 – Łuka 1966: 115–117, 126). Barrow cemeteries have also been found in forested hills of the Lake District (Gdynia-Bernardowo, Gdynia-Cisowa, site 1, Gdynia, site 13 – Łuka 1966: 20, 115; archives MAG). All these sites were explored on a limited scale, typically as an ad hoc measure after destruction of graves was reported, so they provide little information on chronology and structure of burials. Based on the presence of face urns, Łuka linked most of these sites with the "classic phase of the Pomeranian culture" (phase Karczemki acc. to Podgórski 1992; cf. Dzięgielewski

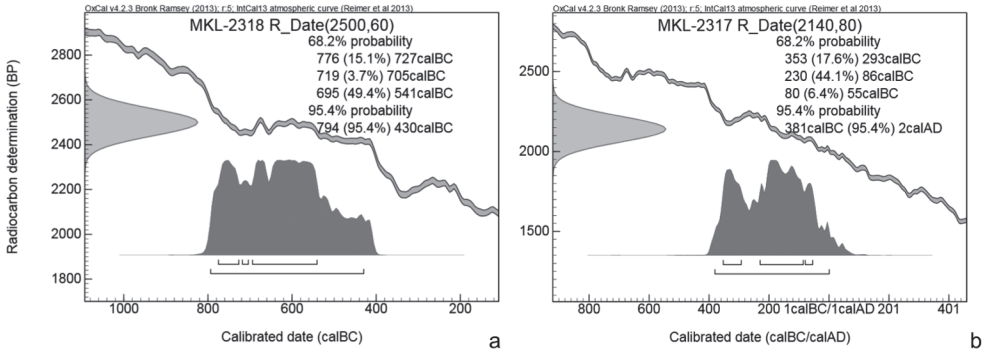

Fig. 26. Gdynia-Karwiny, site 1. Results of calibration of conventional radiocarbon dates of charcoal samples (oak wood): a – MKL-2318 (feat. 1, level 80–90 cm), b – MKL-2317 (feat. 1, level 90–100 cm)

2017, fig. 2), or with period HaC based on such elements as flange lids (Gdynia-Wielki Kack – Łuka 1966, 117). Of similarly low cognitive value are sites (primarily cemeteries) situated to the west of the Kacza Valley, in the Kashubian Lake District: at Chwaszczyno, Gdynia-Wiczlino, and Gdynia-Chwarzno (Łuka 1966: 69–72, 415). Many more finds are known from moraine hills, deforested and long used for farming, in the vicinity of Bojano (Comm. Szemud) (Fudziński M., Fudziński P. 2010, 164–166). The cemetery at Bojano site 3 stands out among these finds; it was investigated and published recently (Fudziński M., Fudziński P. 2010, 166–194). More detailed data is also available for two sepulchral sites situated to the east of Witomino Forest, within the coastal strip of the Kashubian Proglacial Valley, now in the city centre of Gdynia. These are cemeteries at Gdynia (site 1) near the junction of Bema Street and Piłsudskiego Alley (Łuka 1966, 127–128, pl. XXXI:2) and at Gdynia-Św. Maksymiliana Hill (Szymańska 1966). The artefacts (primarily ceramic urns) confirm that all the last three cemeteries were uninterruptedly used from phase Władysławowo (IIA2) until phase Karczemki (IIB1) (cf. Dzięgielewski 2017, fig. 2). They are the closest reference points for the analysed assemblage, both spatially and chronologically. Obviously, this does not mean that any of them needs to be linked with the population who left behind the assemblage from Gdynia-Karwiny analysed here. The attempts at identification of any closer context are possibly hampered by the fact that the area is covered with forest, as traces of cemeteries and settlement from the time period in question are routine finds on even very small patches of deforested land in the zone of erosional valleys. One such settlement was discovered 2 km from the place where the hoard was found, in Gdynia-Wielki Kack site 10. Unfortunately, the way the results of research in this site have been published (Ślusarska, Połczyński 2015, 242–245) does not allow for concluding whether the site may possibly be connected with the hoard in question.

7. Social and ritual aspects of the deposit – discussion

The above attempt at contextualisation of a hoard of bronze artefacts found in amateur conditions has produced significant data for its interpretation, but it has not resulted in the unambiguous determination of the circumstances of its burying. There are grounds for interpreting the closest context of the hoard as a regular, common settlement or camp site (the hearth, the

everyday nature of the pottery assemblage, the posthole), as well as those suggesing its interpretation as a ritual complex, intentionally established for the purpose of burying the bronzes and performing related rituals. This second interpretation seems to be supported by the alleged stone circle, traces of burning amber in the hearth as incense, including perhaps in ceramic containers (see Chapter 4.3.2), and by the very location of the site in an economically non-suitable, narrow valley of the Kacza stream, which is *de facto* an erosional valley cutting through the western slopes of the Kashubian Lake District. Also hampering unequivocal interpretation is the lack of comparative spatial data for hoards from the Bronze and Early Iron Ages: attempts to verify the places of hoards' deposition by means of field research have been undertaken extremely rarely in Pomerania.[18] Nevertheless, even those very few instances suggest a certain repeating pattern of contexts. The first attempt at such verifcation in Pomerania was made in 1917 by B. Ehrlich. Digging in the place where a hoard of five bronze necklaces had been found at Dębice, Dist. Elbląg, he uncovered three hearths with "Early Iron Age sherds" (Ehrlich 1919, 222; he confirmed the precise location of the place of discovery earlier, in November 1915, just one month after the hoard had been found). A similar picture emerges from the description concerning the hoard from Malbork-Wielbark, with two hollow ring ornaments reportedly discovered in a layer of charcoal-saturated deposit (Nowothing 1936, 121).[19] A hearth in the immediate vicinity of a hoard was also recorded during one of the latest attempts at verification, in connection with a Late Bronze Age hoard from Sarbsk, Lębork District. The excavations revealed that the bronzes were originally deposited near a deep hearth with stones (although the distance and spatial relationship are unknown) (Kroczyńska *et al.* 2015, 146, 152–153, figs 2–3). Outside Pomerania, however, archaeological verifications or discoveries of hoards during archaeological research (cf. Kaszewski 1987, 79; Maciejewski 2016, 112–115, 121–123; Kobyliński red. 2014) have thus far brought no information concerning their proximity to hearths.[20] This can certainly also be rejected with respect to hoards deposited in water environments (cf. Blajer 2001, 306–310; Rembisz 2009). Thus, if the account of the discoverer is to be believed (see Chapter 1), the hoard from Gdynia-Karwiny seems to best document the relation between the place of hoard deposition and hearth as very close (distance of 1 m) but separate features. Whether the two structures were created at the same time and were functionally connected must naturally remain in the realm of conjecture.

Stone elements feature quite often in North- and Central Euopean landscapes of hoard deposition (Germ.: "*Hortfundlandschaften"*). These are typically large stones by which bronze objects were buried, stone mounds, pavements, or slabs which were placed over the deposit, or much less frequently stone boxes serving as containers of a kind (Hansen 1994, fig. 203; Blajer 2001, *passim*; Maraszek 2006, 265–267, tab 73–74; Vachta 2016, 80–83, fig. 40; Maciejewski 2016, 121–123). The above publications do not mention any case where a hoard would be buried within a stone circle (although stone arrangement accompanying Rosko hoard could have resembled one – Maciejewski 2016, fig. 2.3.11). However, one should not forget that the morphology, which means the detailed characteristics of the place and circumstances of the hoard's

[18] Aside from very general statements like "the place of the discovery was visited", "the area was checked with a metal detector", etc.

[19] This, by the way, inclined the author of the cited publication to interpret the find as a cremation grave, which in the light of the nature of the finds and other circumstances of the discovery, among others the absence of bones (Nowothing 1936, 123), seems unfounded.

[20] At least with respect to the time period of our interest – examples of hoards buried in the context of hearths or layers of charcoal-saturated deposit are known from Silesia from the Early Bronze Age (Blajer 2001, 261).

burial, is only available for a very small number of cases. In addition, those better documented show absolute lack of uniformity (cf. Maraszek 1998, 75–78). The only distinguishable common purpose of containers (ceramic or organic), stone structures, and specific arrangements of metal artefacts is their compositional enclosure and separation from the outside world (Vachta 2016, 83). The stone circle from Gdynia-Karwiny, with all reservations concerning its intentional nature (see Chapter 4.2) could have well played such role.

The intentional nature of the act of deposition is confirmed by the "storeyed" arrangements of the artefacts – unfortunately only known from the account of the discoverer (for reconstruction see Fig. 27: 1). The bracelet reportedly was lying on two ankle rings placed one atop another. That such an arrangement was likely true is corroborated by accounts concerning other Pomeranian hoards, especially those from Sidłowo in Świdwin District (Kunkel 1931, 51, fig. 15) and Karkowo, in Stargard District (Kunkel 1942; Kozłowska-Skoczka 2012, 177). In the former hoard, ring ornaments were placed in a storey arrangement, with smaller artefacts placed inside a "cylinder" formed in this manner (Fig. 27: 3). At Karkowo, spiral bracelets were additionally placed on a cylinder formed from necklaces (Fig. 27: 2). In the hoard from Strobin, Wieluń District, central Poland, the same role was played by twisted wire necklaces (Kaszewski 1987, 79–81, fig. 2) (Fig. 27: 4–5). Such "tubular" arrangements are favoured by the presence of large ring ornaments (including necklaces) in hoards (Maraszek 1998, 77; Vachta 2016, 83–85). In a way, ornaments arranged in this manner may have been substitutes for containers, since no fragments of clay vessels have been mentioned in the contexts of the above hoards. The described arrangement of objects surely confirms intentional burying of the hoard, although this in itself does not prove ritual motifs behind its deposition. After all, one cannot rule out that a functional criterion was taken into account, and the objects were arranged to fit the shape of the pit. What possibly is a stronger hint at a non-utilitarian motif is the brittleness of the alloy from which the ornaments were made, suggested by the results of chemical analyses (see Chapter 3).

One element that seems to link the entire explored complex with the sphere of ritual behaviours are the lumps of amber (Fig. 11: 2) discovered in the context of "concentration 1", and in particular in the ceiling of the hearth (feature 1). Traces of burning observed on some of the lumps suggest that amber was used as incense. It remains unclear whether it was thrown directly into fire or distilled in ceramic vessels, as possibly indicated by the spectral analyses of tarry substances on two sherds from the vicinity of the hearth. Are such finds, however, limited to ritual contexts? Apparently not, since single amber lumps have been found in hearths in settlements on the shores of the Bay of Gdańsk. In such settlements as Pruszcz Gdański, site 18 (Wiącek 1979, 213) and Pruszcz Gdański, site 12 (Fudziński 2015, 196) these hearths were typical household features, which in the latter case is confirmed by the location of a hearth with amber within a zone where economic-manufacturing activity was performed (cf. Fudziński 2015, 198, fig. 3). Amber lumps (although typically without traces of burning) have also been found in common pits in many settlements from the "Pruszcz" and "Żarnowiec" settlement clusters (cf. Podgórski 1972, 222; Wiącek 1979, 212–213; Bukowski 2002, 110; Rembisz *et al.* 2010, 82; Ignaczak 2011, 153; Dzięgielewski 2017, 325). Therefore, the discovery of partly burned amber in itself does not provide sufficient grounds for claiming a ritual nature of the find. The presence of amber as a tarry substance on the walls of some of the vessels, suggested by spectral analyses, is also difficult to unequivocally interpret. Also here one may consider a "common" (economy-related) aspect of using amber. Furthermore, it is possible that the vessels may have been brought to the site with the walls already covered with tarry substances, so their presence there does not necessarily tell us anything about the nature of the place where the hoard was buried.

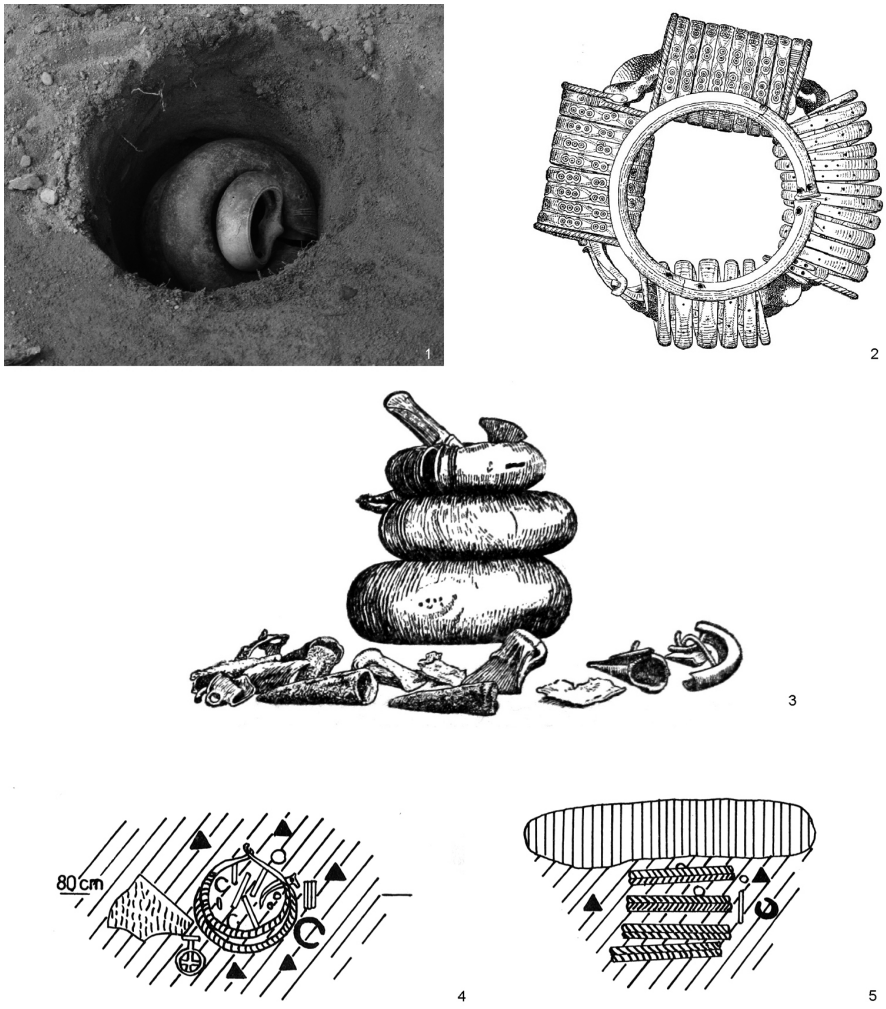

Fig. 27. In situ reconstruction of the arrangement of bronze ornaments in the hoard from Gdynia-Karwiny (1) and the examples of hoards, in which "tubular" arrangement of ring ornaments was recorded (2 – Karkowo, Stargard District, after O. Kunkel 1942; 3 – Sidłowo, Świdwin District, after O. Kunkel 1931; 4–5 – Strobin, Wieluń District, after Z. Kaszewski 1987). Photo A. Longa (1)

As demonstrated above, none of the elements linking the hoard from Gdynia-Karwiny with the sphere of ritual activity could alone be seen as a decisive argument. However, the coincidence of all the circumstances ("non-utilitarian" alloy composition, intentional arrangement of bronzes in the pit, the possible presence of a stone circle, traces of burning amber as incense, alleged melting of amber in vessels, location of the site in the narrow, economically non-suitable valley of the Kacza stream) suggests that the motifs behind the burying of the bronze objects in the ground were not of a "rational" nature (in today's understanding of the word), connected with thesaurization (which means hiding of valuable objects) or other political or economic reasons. We belive they were much more likely buried for sacral purposes. The ritual aspect of this act may never be understood, but one can attempt reconstructing its social meaning. The elimination from "utilitarian" circulation of

a significant amount (approx. 1.2 kg) of non-local raw material (which is how the alloy of copper and – in this case – lead, antimony, and arsenic should be regarded in Pomerania) surely may have served for signalling the prestige of a person or a social group, assuming that this elimination was performed in an ostentatious manner (cf. Fig. 28). The latter is possibly suggested by traces of such ritual behaviours as constructing the alleged stone circle and amber burning – if they indeed relate to the moment when the metal was put into the ground. From this perspective, the purpose of the hoard went beyond just meeting religious requirements (cf. Hansen 1995, 381–384). The act of its deposition can be read as an element of a phenomenon (increasingly well recognised in contemporary archaeology) of prestige competition within – generally rather poorly hierarchised – Early Iron Age communities in Pomerania (cf. Vachta 2016, 174). Among other factors, this rivalry was based on uneven distribution of amber – a raw material important in shaping over-regional connections. One of the manifestations of this phenomenon was the emergence in this area of a specific cultural model, referred to as the Pomeranian culture (cf. Dzięgielewski 2017; 2018).

Fig. 28. Casting of bronze ornaments and deposition of the hoard – stills from the movie inspired by the discovery at Gdynia-Karwiny (participants' costumes are not part of the reconstruction). Directed by Rafał Czapliński, Polsat Play

As mentioned in the introduction, apart from purely scientific purposes, undertaking the verificatory research in the place where the hoard from Gdynia-Karwiny had been found was also meant to raise awareness among amateur detectorists with respect to the necessity of professional excavation of all archaeological finds. Although the cognitive potential of the finds presented in this paper would be even greater if not for the amateur extraction of the hoard itself, we hope that by including "treasure hunters" in investigation of the context of the hoard and by performing a full analytical procedure we have made them realise the potential of modern archaeology and, at least with respect to some of them, how much information is irretrievably lost due to amateur exploration. The discussions we had on this occasion, and the reaction to our actions, have made us believe that this kind of openness and active social education is the right way towards integrated protection of archaeological heritage. The first fruits of this approach may be those cases, only recently emerging in Poland, where detectorists report discoveries of hoards without recovering the metals from the ground by themselves (cf. Stój 2019).

Kontekstualizacja skarbu brązowego z wczesnej epoki żelaza, odkrytego w Gdyni-Karwinach, stan. 1

W początkach 2014 r. w lesie na terenie Gdyni dokonano amatorskiego odkrycia i wydobycia skarbu ozdób brązowych z wczesnej epoki żelaza (bransolety nerkowatej i dwóch dętych obręczy/nagolenników). Fakt ten został zgłoszony do trójmiejskiej fundacji *Invenire Salvum*, a za jej pośrednictwem do służb konserwatorskich i archeologów. W celu poznania okoliczności i warunków zdeponowania brązów jeszcze w tym samym roku dokonano wykopaliskowej weryfikacji miejsca depozycji (Anna Longa, Karol Dzięgielewski). Okazało się, że w najbliższym kontekście brązów, ułożonych według odkrywcy poziomo jeden na drugim (z najmniejszą bransoletą na górze) w dołku sięgającym 60 cm głębokości (obiekt 3), znajduje się skupisko kamieni narzutowych, z których część mogła zostać ułożona intencjonalnie, w celu oznaczenia w ten sposób miejsca złożenia depozytu. Tuż obok owego domniemanego kamiennego kręgu (o średnicy ok. 2 m) znajdowało się głębokie palenisko (obiekt 1) używane do rozgrzewania kamieni, a także – do kadzenia bursztynem, którego reszki zachowały się w postaci nadpalonych grudek oraz prawdopodobnie także śladów na ściankach naczyń, jak wynika z analiz spektralnych zachowanych osadów. Część cech zbadanego kompleksu, takich jak obecność kolistej konstrukcji kamiennej, ślady palenia bursztynu, lokalizacja miejsca depozycji w niezbyt dogodnym do założenia osiedla wąskim wypłaszczeniu dolinki, a także skład chemiczny samych metali, może wskazywać na pozautylitarny charakter depozytu. Ozdoby wykonane zostały z porowatego stopu miedzi z wysokim dodatkiem ołowiu, antymonu i arsenu, a nie cyny, co mogło sprzyjać ich kruchości i nikłej wartości użytkowej.

Ceramika znaleziona w pobliżu miejsca zdeponowania brązów (ok. 250 fragmentów z maksymalnie 50–115 naczyń) nie różni się jednak od spotykanej na ówczesnych osadach (np. w Juszkowie, Brzynie czy Gnieżdżewie). Skarb i jego kontekst należy datować na fazę przejściową pomiędzy okresem HaC1 i HaC2 (HaC1b – HaC2a; przełom VIII i VII w. p.n.e.).

Jest to kolejne na Pomorzu Wschodnim znalezisko skarbu z okresu ich najczęstszego występowania (przełom epoki brązu i wczesnej epoki żelaza), jednak zarazem pierwsze, które doczekało się kompleksowej i interdyscyplinarnej weryfikacji archeologicznej, przynoszącej szereg konkretnych i zaskakujących wyników. Zdają się one dobitnie zaświadczać na rzecz interpretacji fenomenu deponowania skarbów przedmiotów metalowych jako zjawiska przede wszystkim rytualnego oraz społecznego (jako przejawu normy polegającej na rywalizacji prestiżowej). Uzasadnione religijnie, ostentacyjne pozbywanie się cennych wyrobów wykonanych z importowanego surowca mogło zapewniać jednostkom lub grupom osiąganie wyższego statusu społecznego.

References

Andrzejowska M., 2003 *Cmentarzysko fazy wielkowiejskiej na stan. 1 we Władysławowie Chłapowie, woj. pomorskie*, Wiadomości Archeologiczne, 56, pp. 145–188.

2004 *Cmentarzyska w Wielkiej Wsi i Swarzewie w świetle kartoteki Carla-Axela Moberga*, Pruthenia Antiqua, 1, pp. 227–271.

Blajer W., 2001 *Skarby przedmiotów metalowych z epoki brązu i wczesnej epoki żelaza na ziemiach polskich,* Kraków: Księgarnia Akademicka.

Bukowski Z., 1998 *Pomorze w epoce brązu w świetle dalekosiężnych kontaktów wymiennych,* Seria Monografii,104, Gdańsk: Gdańskie Towarzystwo Naukowe.

Chabal L., 1997 *Forêts et sociétés en Languedos (Néolithic final, Antiquité tardive). L´athracologie, méthode et paléoécologie*, Documents d´Archéologie Française, 63, Paris: Ed. de la Maison des Sciences de l´Homme.

Dziechciarz P., 2018 *Gnieżdżewo, stanowiska 1 i 4. Osady z przełomu epok brązu i żelaza na Pomorzu Wschodnim*, Ocalone Dziedzictwo Archeologiczne – Miniatury, 3, Pękowice – Warszawa – Gdańsk: Wydawnictwo Profil-Archeo, Wydział Historyczny Uniwersytetu Warszawskiego, Muzeum Archeologiczne w Gdańsku.

Dzięgielewski K., 2003 *Osada ludności kultury pomorskiej na Górze Markowca w Rumi, pow. Wejherowo*, Pomorania Antiqua, 19, pp. 83–115.

2005 *Zarys procesów osadniczych kultury pomorskiej w mikroregionach Pradoliny Kaszubskiej i Kępy Oksywskiej*, (in:) M. Fudziński, H. Paner (eds.), Aktualne problemy kultury pomorskiej, Gdańsk: Muzeum Archeologiczne w Gdańsku, pp. 385–404.

2010 *Osada z młodszej i późnej epoki brązu na stanowisku 48 w Wojniczu, pow. Tarnów*, (in:) J. Chochorowski (ed.), Wojnicz 18 i 48 – osady z epoki brązu, żelaza i średniowiecza, Via Archaeologica. Źródła z badań wykopaliskowych na trasie autostrady A4 w Małopolsce, Kraków, pp. 55–116.

2013 *Hrubieszów, stanowisko 104. Osada z wczesnej epoki żelaza na wschodniej Lubelszczyźnie*, Ocalone Dziedzictwo Archeologiczne – Miniatury, 1, Pękowice – Hrubieszów: Profil-Archeo, Muzeum im. S. Staszica w Hrubieszowie.

2017 *Late Bronze and Early Iron Age communities in the northern part of the Polish Lowland (1000–500 BC),* (in:) U. Bugaj (ed.), The Past Societies. Polish lands from the first evidence of human presence to the early Middle Ages. Volume 3: 2000–500 BC, Warszawa: Instytut Archeologii i Etnologii PAN, pp. 295–340.

2018 *"Bernsteinherren" or humble amber gatherers? Notes on social organisation in Eastern Pomerania during the Early Iron Age*, (in:) M. Trefný (ed.), The Early Iron Age in Central Europe. Proceedings of the conference held on the 2nd–4th of July 2015 in Hradec Králové, Czech Republic/Die frühe Eisenzeit in Mitteleuropa. Sammelband von der Tagung abgehalten am 2.–4. Juli 2015 in Hradec Králové, Tschechische Republik, Hradec Králové: Gaudeamus, 78–91.

In preparation, *Transformacje kulturowe na przełomie epoki brązu i epoki żelaza na Pomorzu Wschodnim.*

Dzięgielewski K., Szczerba R., Chudzińska B., 2011 *Osadnictwo z wczesnej epoki brązu, okresu halsztackiego i starszego okresu przedrzymskiego oraz ślady działalności człowieka w czasach średniowiecznych i nowożytnych na stanowisku 17 w Podłężu, pow. wielicki,* (in:) S. Kadrow (ed.), Raport 2005–2006, Warszawa, pp. 315–348.

Ehrlich B., 1919 *Der Bronzedepotfund von Dambitzen Kr. Elbing, Westpreußen*, Mannus, 9, pp. 222–225.

Fudziński M., 2015 *Osada z wczesnej epoki żelaza w Pruszczu Gdański, stanowisko 12*, Pomorania Antiqua, 24, pp. 191–202.

Fudziński M., Fudziński P., 2010 *Bojano we wczesnej epoce żelaza*, Pomorania Antiqua, 23, pp. 163–198.

Fudziński P., Fudziński M., 2010 *Skarb przedmiotów brązowych z Redy-Rekowa stanowisko nr 19*, Pomorania Antiqua, 23, pp. 209–214.

Fudziński P., Ślusarska K., 2017 *Ośrodek starożytnego brązownictwa pomorskiego we wczesnej epoce żelaza w Juszkowie, gmina Pruszcz Gdański*, Gdańsk: Muzeum Archeologiczne w Gdańsku.

Garbacz-Klempka A., 2018 *Synteza badań archeometalurgicznych artefaktów z epoki brązu. Eksperymentalna rekonstrukcja dawnych stopów miedzi i technologii*, Kraków: Akapit.

Gibson A., Woods A., 1997 *Prehistoric pottery for the archaeologists*, Leicester: A&C Black.

Hammer Ø., Harper D.A.T., Ryan P.D., 2001 PAST: *Paleontological statistics software package for education and data analysis*, Palaeontologia Electronica 4/1 (http://palaeo-electronica.org/2001_1/past/issue1_01.htm).

Hansen S., 1994 *Studien zu den Metalldeponierungen während der älteren Urnenfelderzeit zwischen Rhônetal und Karpatenbecken. Teil 1*, Universitätsforschungen zur prähistorischen Archäologie, 21, Bonn: Dr. Rudolf Habelt GmbH.

Harding A., Ostoja-Zagórski J., Palmer C., Rackham J., 2004 *Sobiejuchy: a fortified site of the Early Iron Age in Poland*, Polskie Badania Archeologiczne, 35, Warsaw: Institute of Archaeology and Ethnology, Polish Academy of Sciences.

Honeck M., 2009 *Nichts als heiße Steine? Zur Deutung der Brenngruben der späten Bronzezeit und frühen Eisenzeit in Deutschland*, Universitätsforschungen zur prähistorischen Archäologie, 166, Bonn: Dr. Rudolf Habelt GmbH.

Ignaczak M., 2011 *Kultura łużycka i pomorska*, (in:) J. Bednarczyk, A. Romańska (eds.), Wielokulturowa osada w Juszkowie-Rusocinie, gm. Pruszcz Gdański, woj. pomorskie, stan. 28, Via Archaeologica Posnaniensis, 3, Poznań: Wydawnictwo Poznańskie, pp. 141–169.

Kaszewski Z., 1987 *Skarb z V okresu epoki brązu w Strobinie, gmina Konopnica*, *województwo sieradzkie*, Prace i Materiały Muzeum Archeologicznego i Etnograficznego w Łodzi – Seria Archeologiczna, 34, pp. 79–99.

Klichowska M., 1979 *Zboże z osady z przełomu epoki brązu i żelaza w Juszkowie, gm. Pruszcz Gdański,* Pomorania Antiqua, 8, pp. 141–154.

Kneisel J., Dibbern H., Diers S., 2010 *Ein Aufnahmesystem für bronzezeitliche Keramik*, (in:) B. Horejs, R. Jung, P. Pavúk (eds.), Analysing pottery. Processing – Classification – Publication, Studia Archaeologica et Medievalia, 10, Bratislava, 121–142.

Kobyliński Z. (ed.), 2014 *Contextualisation of the hoard from Vettersfelde/Witaszkowo: archaeological excavation at Kozów, site 2 in the Lubusz Land. Kontekstualizacja skarbu z Vettersfelde/Witaszkowa: badania archeologiczne na stan. 2 w Kozowie w Ziemi Lubuskiej*, Zielona Góra: Fundacja Archeologiczna, Instytut Archeologii UKSW w Warszawie, Instytut Archeologii i Etnologii PAN.

Kondracki J., 1978 *Geografia fizyczna Polski*, Warszawa: PWN.

Kostrzewski J., 1958 *Kultura łużycka na Pomorzu*, Poznań: Poznańskie Wydawnictwo Naukowe.

Kossinna G., 1919 *Meine Reise nach West- und Ostpreussen und meine Berufung zu Generalfeldmarschall v. Hindenburg im August 1915*, Mannus, 9, pp. 119–195.

Kozłowska-Skoczka D., 2012 *Epoka brązu – wczesna epoka żelaza – katalog zabytków*, (in:) K. Kowalski, D. Kozłowska-Skoczka (eds.), Zaginione – ocalone. Szczecińska kolekcja starożytności pomorskich. Lost – saved. The Pomeranian Antiquities Collection of Szczecin, Szczecin: Muzeum Narodowe w Szczecinie, pp. 119–192.

Kroczyńska A., Knapp B., Machajewski H., 2015 *Skarb przedmiotów brązowych odkryty na osadzie ludności kultury łużyckiej w Sarbsku, powiat lęborski, stanowisko 16*, Pomorania Antiqua, 24, pp. 145–164.

Kucypera P., 2017 *Omówienie wyników analiz spektralnych przedmiotów ze stopów miedzi ze skarbu charzykowskiego,* (in:) H. Rząska, K. Walenta (eds.), Brązy ukryte w ziemi… Łużycki skarb z Charzyków, Chojnice: Muzeum Historyczno-Etnograficzne im. J. Rydzkowskiego, pp. 83–99.

Kunkel O., 1931 *Pommersche Urgeschichte in Bildern. Tafelteil*, Stettin: Leon Sauniers.

1942 *Ein spätbronzezeitlicher Hortfund von Karkow, Kr. Saatzig*, Monatsblätter der Gesellschaft für Pommersche Geschichte und Altertumskunde, 56 (1-12), pp. 24–28.

La Baume W., 1931 *Zur Kenntnis der Metall-Technik in der Bronzezeit und älteren Eisenzeit,* (in:) 50 Jahre Museum für Naturkunde und Vorgeschichte (Westpreußisches Provinzial-Museum) in Danzig 1880–1930, Schriften der Naturforschenden Gesellschaft in Danzig N.F., 19/3, pp. 123–151.

Latałowa M., 1997 *Wpływ osadnictwa epoki brązu i wczesnej epoki żelaza na późnoholoceńską historię lasów na Pomorzu*, (in:) W. Fałtynowicz, M. Latałowa, J. Szmeja (eds.), Dynamika i ochrona roślinności Pomorza. Materiały z sympozjum, Gdańsk, 28–30 września 1995 r., Gdańsk – Poznań: Bogucki Wydawnictwo Naukowe, pp. 113–124.

Lissauer A., 1891 *Alterthümer der Bronzezeit in der Provinz Westpreussen und den angrenzenden Gebieten*, Abhandlungen zur Landeskunde der Provinz Westpreussen, 2, Danzig.

Lityńska-Zając M., Wasylikowa K., 2005 *Przewodnik do badań archeobotanicznych*, Vademecum Botanicum, Poznań: Sorus.

Łuka L.J., 1966 *Kultura wschodniopomorska na Pomorzu Gdańskim. Tom I. Materiały,* Biblioteka Archeologiczna, 19, Wrocław: Polskie Towarzystwo Archeologiczne; Zakład Narodowy Im. Ossolińskich.

Maciejewski M., 2016 *Metal – granica – rytuał. Badania nad depozytami przedmiotów metalowych w kontekście sieci osadniczej,* Archaeologia Bimaris. Monografie, 7, Poznań: Wydawnictwo Nauka i Innowacje.

2018 *Perspektywy badań nad skarbami z późnej epoki brązu i wczesnej epoki żelaza*, Śląskie Sprawozdania Archeologiczne, 60/1, pp. 279–313.

Maclean P., 1998 *Forgotten realms, forgotten alloys: Exotic metallurgy in Bronze Age Europe,* (in:) Early Materials Forum (EMF) – January 1998. Abstracts, http://www.ucl.ac.uk/emf/meetings/jan98/abstracts/pmaclean.html [access date: 26.08.2014].

Maraszek R., 1998 *Spätbronzezeitliche Hortfunde entlang der Oder*, Universitätsforschungen zur prähistorischen Archäologie, 49, Bonn: Dr Rudolf Habelt GmbH.

2006 *Spätbronzezeitliche Hortfundlandschaften in atlantischer und nordischer Metalltradition,* Veröffentlichungen des Landesamtes für Denkmalpflege und Archäologie Sachsen-Anhalt – Landesmuseum für Vorgeschichte, 60/I–II, Halle (Saale): Landesmuseum für Vorgeschichte.

Matuszewska A., 2009 *Bursztyn bałtycki i inne żywice kopalne w świetle badań fizykochemicznych (Baltic amber and other fossil resins in the light of physicochemical studies),* Przegląd Geologiczny, 57/12, pp. 1078–1083.

2012 *Chemiczna budowa bursztynu (sukcynitu),* (in:) B. Kosmowska-Ceranowicz, W. Gierłowski, E. Sontag (eds.), Amberif 2012. XIX Seminarium „Badania inkluzji i innych właściwości bursztynu – najnowsze wyniki", Gdańsk, 24 marzec 2012, Gdańsk: Amberif, pp. 3–9.

2016 *Zarys historii badań kwasu bursztynowego w bursztynie bałtyckim,* (in:) E. Wagner-Wysiecka, B. Kosmowska-Ceranowicz (eds.), Amberif 2016. Bursztyn bałtycki w kalejdoskopie czasu, Gdańsk: Amberif, pp. 31–34.

Matuszkiewicz J. M., 2008 *Potencjalna roślinność naturalna Polski*, Warszawa: IGiPZ PAN.

Mendyk E., 2012 *Badanie bursztynu bałtyckiego metodą FTIR-ATR*, (in:) B. Kosmowska-Ceranowicz, W. Gierłowski, E. Sontag (eds.), Amberif 2012. XIX Seminarium „Badania inkluzji i innych właściwości bursztynu – najnowsze wyniki", Gdańsk, 24 marzec 2012, Gdańsk: Amberif, pp. 11–16.

Montero I., Rovira S., Delibes G., Fernández-Manzano J., Fernández-Posse M. D., Herrán J. I., Martín C., Maicas R., 2003 *High leaded bronze in the Late Bronze Age metallurgy of the Iberian Peninsula,* (in:) Proceedings of the International Conference "Archaeometallurgy in Europe", 24–26 September 2003. Vol. 2, Milan: Assoziacione Italiana di Metallurgia, pp. 39–46.

Moskal-del Hoyo M., Wachowiak M., Blanchette R. A., 2010 *Preservation of fungi in charcoal,* Journal of Archaeological Science, 37/9, pp. 2106–2116.

Muzolf B., 2002 *Wyniki ratowniczych badań archeologicznych na terenie odkrywki "Szczerców" KWB "Bełchatów" S.A. na stan. 12 w Grabku, gm. Szczerców, woj. łódzkie. Kompleks osadniczy z okresów halsztackiego i lateńskiego*, (in:) R. Grygiel (ed.), Badania archeologiczne na terenie odkrywki "Szczerców" Kopalni Węgla Brunatnego "Bełchatów" S.A., tom 2, Łódź: Fundacja Badań Archeologicznych im. Konrada Jażdżewskiego, pp. 121–384.

Nowothing W., 1936 *Zwei gerippte Stöpselringe aus Marienburg*, Mannus, 28, pp. 121–123.

Orton C., Tyers P., Vince A., 1993 *Pottery in archaeology*, Cambridge Manuals in Archaeology, Cambridge: University Press.

Pabst-Dörrer S., 2000 *Untersuchungen zu hallstattzeitlichen Frauentrachten mit Spiralbrillenfibeln zwischen Alpen, Karpaten und Ostsee*, Internationale Archäologie, 51, Rahden/Westf.: Marie Leidorf GmbH.

Pawlak E., Pawlak P., 2008 *Osiedla wczesnośredniowieczne w Markowicach pod Poznaniem wraz z pozostałościami osadnictwa pradziejowego*, Prace Komisji Archeologicznej PTPN, 25, Poznań: PTPN.

Petersen E., 1929 *Die frühgermanische Kultur in Ostdeutschland und Polen*, Vorgeschichtliche Forschungen, 2, Berlin.

Pietrzak M., Podgórski J. T., 2005 *Chłapowo 2, powiat pucki woj. pomorskie. Cmentarzysko fazy wielkowiejskiej kultury pomorskiej*, Gdańsk: Muzeum Archeologiczne w Gdańsku.

Pike A., 2002 *Analysis of Caucasian metalwork – The use of antimonial, arsenical and tin bronze in the Late Bronze Age,* (in:) J. Curtis, M. Kruszynski (eds.), Ancient Caucasian and related material in the British Museum, The British Museum Occasional Papers, 121, London, pp. 87–92.

Piotrowska M., 2013 *Epoka żelaza w dorzeczu środkowej Słupi*, Spatium Archaeologicum, 5, Łódź – Poznań: Nauka i Innowacje.

Podgórski J. T., 1972 *Tymczasowe wyniki badań wykopaliskowych prowadzonych w 1969 r. na stanowisku 3 w Juszkowie, w pow. gdańskim*, Pomorania Antiqua, 4, pp. 205–234.

1992 *Fazy cmentarzysk kultury łużyckiej i pomorskiej na Pomorzu Wschodnim*, (in:) S. Czopek (ed.), Ziemie polskie we wczesnej epoce żelaza i ich powiązania z innymi terenami, Rzeszów: Muzeum Okręgowe, pp. 199–214.

Reimer P., Bard E., Bayliss A., Beck J., Blackwell P., Ramsey C. *et al.***,** 2013 *IntCal13 and Marine13 radiocarbon age calibration curves 0–50,000 years cal BP,* Radiocarbon, 55/4, pp. 1869–1887.

Rembisz A., 2009 Znaleziska naczyń, broni i narzędzi z Jeziora Gągnowskiego w Nętnie, gm. Drawsko Pomorskie (stanowisko 38), (w:) J. Gackowski (red.), *Archeologia epok brązu i żelaza. Studia i materiały*, Toruń: Wydawnictwo UMK, pp. 93–121.

Rembisz A., Pawlak T., Kościński B., 2010 *Wyniki badań wykopaliskowych w Gdańsku-Lipcach na stanowisku 5 na trasie Południowej Obwodnicy Gdańska (badania 2008–2009 – SAZ nr 161/5/4)*, Gdańsk, Archive of the National Heritage Board of Poland (typescript).

Rice P. M., 1987 *Pottery analysis. A sourcebook*, Chicago – London: University of Chicago Press.

Schacht S., 1982 *Die Nordischen Hohlwulste der frühen Eisenzeit*, Wissenschaftliche Beiträge der Martin-Luther-Universität Halle-Wittenberg, 68/L18, Halle (Salle).

Schumann H., 1892 *Gegossene und getriebene Bronze-Hohlwülste aus Pommern*, Zeitschrift für Ethnologie, 24, pp. 361–366.

1900 *Der Bronzedepotfund von Vietkow (Kreis Stolp) und die Beziehungen Pommerns zur Westschweiz während der Bronzezeit*, Baltische Studien Neue Folge, 4, pp. 138–152.

Schweingruber F. H., 1982 *Mikroskopische Holzanatomie*, Teufen: F. Flück-Wirth. Internationale Buchhandlung für Botanik und Naturwissenschaften.

1990 *Anatomie europäischer Hölzer*, Bern – Stuttgart: Paul Haupt.

Sprockhoff E., 1956 *Jungbronzezeitliche Hortfunde der Südzone des Nordischen Kreises (Periode V). Band I,* Römisch-Germanisches Zentralmuseum zu Mainz. Katalog, 16, Mainz: Verlag des Römisch-Germanischen Zentralmuseums.

Stępnik T., 2011 *Skład taksonomiczny prób drewna i węgli drzewnych ze stan. 28 w Juszkowie-Rusocinie*, (in:) J. Bednarczyk, A. Romańska (eds.), Wielokulturowa osada w Juszkowie-Rusocinie, gm. Pruszcz Gdański, woj. pomorskie, stan. 28, Via Archaeologica Posnaniensis, 3, Poznań: Wydawnictwo Poznańskie, pp. 269–272.

Strobin A., Molęda N., 2013 *Piece do wypału ceramiki z wczesnej epoki żelaza odkryte w miejscowości Brzyno, pow. pucki*, Gdańskie Studia Archeologiczne, 3, pp. 211–242.

Stój B., 2019 *Uprząż sprzed 3000 lat*, Archeologia Żywa 3/2019 (73), pp. 30–32.

Stubenrauch A., 1897 *Der Bronze-Moorfund von Podewilshausen, Kreis Stolp*, Monatsblätter der Gesellschaft für Pommersche Geschichte und Altertumskunde, 11/2, pp. 23–25.

Szamałek K., 1987 *Kruszwicki zespół osadniczy w młodszej epoce brązu i w początkach epoki żelaza,* Polskie Badania Archeologiczne, 26*,* Wrocław: IHKM PAN; Zakład Narodowy im. Ossolińskich.

Szymańska A., 1966 *Sprawozdanie z badań wykopaliskowych prowadzonych na cmentarzysku kultury pomorskiej w Gdyni-Wzgórze Nowotki,* Sprawozdania Archeologiczne, 18, pp. 90–94.

Ślusarska K., Polczyński Ł., 2015 *Wyniki ratowniczych badań wykopaliskowych na stanowisku wielokulturowym Gdynia Wielki Kack 10, gm. loco, woj. pomorskie*, Pomorania Antiqua, 24, pp. 239–252.

Tackenberg K. 1971 *Die jüngere Bronzezeit in Nordwestdeutschland. Teil I. Die Bronzen*, Veröffentlichungen der urgeschichtlichen Sammlungen des Landesmuseums zu Hannover, 19, Hildesheim: August Lax Verlagsbuchhandlung.

Trachsel M., 2004 *Untersuchungen zur relativen und absoluten Chronologie der Hallstattzeit,* Universitätsforschungen zur prähistorischen Archäologie, 104/1, 104/2), Bonn: Dr. Rudolf Habelt GmbH.

Tyniec A., 1990a *Bransolety nerkowate z młodszej epoki brązu. Część I. Materiały*, Materiały Zachodniopomorskie, 33, pp. 49–146.

1990b *Bransolety nerkowate z młodszej epoki brązu. Część II,* Materiały Zachodniopomorskie, 35/36, pp. 7–48.

Vachta T., 2016 *Bronzezeitliche Hortfunde und ihre Fundorte in Böhmen*, Berlin Studies of the Ancient World, 33, Berlin: Edition Topoi.

Wiącek B., 1979 *Z zagadnień produkcyjnych we wczesnej epoce żelaza na Pomorzu Wschodnim*, (in:) T. Malinowski (ed.), Problemy kultury pomorskiej, Koszalin: Muzeum Okręgowe, pp. 209–218.

Wierzbicki P. 2011 *Wykorzystanie rozgrzanych kamieni jako transmitorów ciepła na stanowiskach typu burnt mound w Irlandii*, (in:) K. Dzięgielewski, Ł. Oleszczak (eds.), Po drugiej stronie… Raporty przyjaciół-archeologów dla Wojtka Cholewy „Jonesa", Pękowice: Profil, pp. 89–99.