

Abhandlung

Grzegorz Osipowicz, Andrzej Bokiniec, Krzysztof Kurzyk, Daniel Makowiecki, Dorota Bienias, Tomasz Górzyński, Michał Jankowski, Krystyna Jędrychowska-Dańska, Małgorzata Kępa, Anna Kozłowska, Tomasz Kozłowski, Agnieszka Noryśkiewicz, Tomasz Płoszaj, Laurie J. Reitsema, Beata Stepańczak, Krzysztof Szostek, Piotr Weckwerth, Henryk W. Witas

The Late Neolithic sepulchral and ritual place of site 14 in Kowal (Kuyavia, Central Poland)

DOI 10.1515/pz-2014-0018

Abstract: Forschungsgegenstand dieses Artikels ist ein Begräbnis- und Ritualplatz der Kugelamphoren-Kultur der Fundstätte 14 in Kowal (Zentral-Polen). Die Stätte umfasst einen Submegalithen sowie einen Ritualplatz mit Tiergräbern und einer menschlichen Bestattung. Der Komplex kann auf die Zeit zwischen 3250/3100 und 2400/2150 v. Chr. datiert werden. Analysen haben gezeigt, dass der Platz über eine lange Zeit benutzt wurde, und dass die durchgeführten Rituale sehr komplex waren. Beweise wurden gefunden, dass an einigen Stellen rituelle Handlungen ohne Unterbrechung über viele Jahre durchgeführt wurden und einzelne Tieropfer und Niederlegungen nur durch einen Zeitraum von wenigen Jahren

voneinander getrennt waren. Die Fund-Struktur einiger Gruben zeigt eine sehr penible Organisation des geheiligten Platzes und ermöglicht an einigen Stellen sogar eine Unterscheidung in Nutz- und rituelle Zonen. Weitere wichtige Informationen wurden durch die Untersuchung einer menschlichen Grablege an dieser Stätte gewonnen. Die Analyse der Grabbeigaben hat deren Natur als rituelle Gaben gezeigt; weiter weist sie auf eine dominante Rolle von Tieren im täglichen Leben der verstorbenen Person hin. Wichtige Daten wurden durch die paläo-biologische Untersuchung der menschlichen Knochen gewonnen. Die paläo-serologische Analyse ergab die Blutgruppe der bestatteten Person. Dies ist der erste derartige Nachweis in der Geschichte der europäischen neolithischen Forschung. Bei den Ergebnissen der DNA-Analyse handelt es

Grzegorz Osipowicz: Institute of Archaeology, Nicolaus Copernicus University, ul. Szosa Bydgoska 44/48, 87–100 Toruń; E-mail: grezegor@umk.pl

Andrzej Bokiniec: Institute of Archaeology, Nicolaus Copernicus University, ul. Szosa Bydgoska 44/48, 87–100 Toruń; E-mail: bokinicz@his.uni.torun.pl

Krzysztof Kurzyk: Institute of Archaeology, Nicolaus Copernicus University, ul. Szosa Bydgoska 44/48, 87–100 Toruń; E-mail: kurzyk.k@gmail.com

Daniel Makowiecki: Institute of Archaeology, Nicolaus Copernicus University, ul. Szosa Bydgoska 44/48, 87–100 Toruń; E-mail: makdan@umk.pl

Dorota Bienias: Institute of Archaeology, Nicolaus Copernicus University, ul. Szosa Bydgoska 44/48, 87–100 Toruń; E-mail: dosiab@umk.pl

Tomasz Górzyński: Institute of Archaeology, Nicolaus Copernicus University, ul. Szosa Bydgoska 44/48, 87–100 Toruń; E-mail: tomaszgo@his.uni.torun.pl

Michał Jankowski: Faculty of Earth Sciences, Nicolaus Copernicus University, ul. Gagarina 9, 87–100 Toruń; E-mail: mijank@umk.pl

Krystyna Jędrychowska-Dańska: Department of Molecular Biology, Medical University of Lodz, ul. Narutowicza 60, 90–136 Łódź; E-mail: krystyna.jedrychowska-danska@umed.lodz.pl

Małgorzata Kępa: Institute of Zoology, Jagiellonian University, ul. Gronostajowa 9, 30–387 Kraków; E-mail: malgorzata.kepa@uj.edu.pl

Anna Kozłowska: Institute of Zoology, Jagiellonian University, ul. Gronostajowa 9, 30–387 Kraków; E-mail: a.kozlowska@uj.edu.pl

Tomasz Kozłowski: Department of Anthropology, Nicolaus Copernicus University, ul. Gagarina 9, 87–100 Toruń; E-mail: kozlow@biol.uni.torun.pl

Agnieszka Noryśkiewicz: Institute of Archaeology, Nicolaus Copernicus University, ul. Szosa Bydgoska 44/48, 87–100 Toruń; E-mail: anorys@uni.torun.pl

Tomasz Płoszaj: Department of Molecular Biology, Medical University of Lodz, ul. Narutowicza 60, 90–136 Łódź; E-mail: tomasz.ploszaj@umed.lodz.pl

Laurie J. Reitsema: Bioarchaeology and Biochemistry Laboratory, University of Georgia, 250 Baldwin Hall: Jackson St., Athens, GA 30602–1619, USA; E-mail: reitsema@uga.edu

Beata Stepańczak: Institute of Zoology, Jagiellonian University, ul. Gronostajowa 9, 30–387 Kraków; E-mail: b.stepanczak@uj.edu.pl

Krzysztof Szostek: Institute of Zoology, Jagiellonian University, ul. Gronostajowa 9, 30–387 Kraków; E-mail: szosy@wp.pl

Piotr Weckwerth: Faculty of Earth Sciences, Nicolaus Copernicus University, ul. Gagarina 9, 87–100 Toruń; E-mail: pweck@uni.torun.pl

Henryk W. Witas: Department of Molecular Biology, Medical University of Lodz, ul. Narutowicza 60, 90–136 Łódź; E-mail: henryk.witas@umed.lodz.pl

sich um die erste Beschreibung von genetischen Eigenschaften eines Vertreters der Kugelamphoren-Kultur in der Literatur und zudem um eine von nur wenigen solcher Untersuchungen eines neolithischen Menschen. Einige der nachgewiesenen Allele sind die ältesten Beispiele dieses speziellen Allel-Typs, die in menschlichen Überresten bis heute identifiziert wurden. Die DNA-Analysen belegen eine Laktose-Intoleranz der bestatteten Person, sie legen weiter eine genetische Verwandtschaft mit der Bevölkerung aus der Region des Fruchtbaren Halbmondes nahe. Die Analyse des stabilen Sauerstoff-Isotopen-Verhältnisses zeigt Muster für häufigeren Ortswechsel und das Entwöhnungsalter. Analysen von stabilen Kohlenstoff- und Stickstoff-Isotopen-Verhältnissen haben Rückschlüsse auf die Ernährung ermöglicht; besondere Aufmerksamkeit verdient die Tatsache, dass bis zu 25 % der Kohlenhydrat-haltigen Nahrung aus Hirse bestanden hat. Das ist der früheste Isotopen-gestützte Nachweis von Hirse in der menschlichen Ernährung in Mitteleuropa.

Keywords: Kugelamphoren-Kultur; Neolithikum; Polen; Kujawien, Ritualplatz, paläo-biologische Forschung

Résumé: Le site 14 de Kowal en Pologne centrale, un complexe rituel appartenant à la culture des amphores globulaires, forme le sujet de cet article. Le site comporte un sub-mégalithe, une structure rituelle avec des dépôts d'animaux et une sépulture humaine. Il fut occupé pendant une longue période allant de 3250/3100 à 2400/2150 av. J.-C. et les rituels étaient complexes: certains furent célébrés au même endroit pendant longtemps, tandis que les sacrifices et dépôts d'animaux n'étaient séparés que par de courts intervalles de peut-être quelques années. Le remplissage de plusieurs fosses démontre une organisation précise de l'espace sacré, et il a même été possible de faire une distinction entre les actes de déposition rituelle et les dépôts de type utilitaire à l'intérieur de ces fosses. L'étude de la sépulture humaine a également fourni d'importants indices. Il en ressort qu'un individu intentionnellement choisi parmi les membres de 'l'aristocratie' locale a été la victime d'un meurtre rituel. L'analyse du mobilier funéraire indique qu'il s'agit d'offrandes rituelles et suggère que les animaux jouaient un rôle déterminant dans la vie de cet individu. L'étude de ses ossements a fourni un important ensemble de données, y compris les résultats d'une analyse sérologique permettant d'identifier – pour la première fois pour le Néolithique européen – le groupe sanguin de cet homme. Dans une étude également pionnière pour la culture des amphores globulaires, l'analyse ADN a permis de décrire la composition génétique d'un de ses membres, une rareté

dans les études sur le Néolithique. Certains allèles sont les plus anciens exemplaires d'un type particulier d'allèles jusqu'à présent découvert dans des restes humains. Les données de l'analyse de l'ADN de cet individu suggèrent qu'il était intolérant au lactose et qu'il avait des affinités génétiques avec le Croissant fertile. Les résultats de l'analyse des isotopes stables de l'oxygène peuvent être interprétés soit en termes de mobilité ou de sevrage. Ceux provenant de l'analyse des isotopes stables du carbone et de l'azote nous permettent de reconstruire l'alimentation de notre individu ; en particulier le millet fournissait jusqu'à 25 % de sa consommation en glucides. Ce résultat constitue le premier indice isotopique de la présence du millet dans l'alimentation des populations de l'Europe centrale.

Mots-clefs: Culture des amphores globulaires; Néolithique; Pologne; Kuyavia; rituel; sub-mégalithe

Abstract: Site 14 in Kowal (central Poland), a funerary and ritual centre of the Globular amphora culture forms the subject of this article. The site includes a sub-megalith, a ritual feature with animal burials and a human burial. The complex can be dated to a period spanning from 3250/3100 to 2400/2150 BC; it was used over a long period, and the rituals carried out were complex. Rituals were performed over many years in certain areas, while individual acts of animal sacrifice and deposition may have been separated by a short interval of just a few years. The fill of some pits shows that the sacred space was carefully organised and it has been possible to distinguish between some utilitarian and ritual deposits within them. Other important information is provided by the study of a human burial discovered at the site. It is possible that a deliberately chosen individual from the tribal 'aristocracy' was the victim of a ritual murder. The analysis of the grave goods reveals that they were ritual offerings, and these suggest that animals played a dominant role in the deceased man's daily life. The study of his bones provides important new insights, including those from a palaeo-serological analysis revealing his blood group, a first in the history of European Neolithic research. The results of DNA analysis constitute the first description of the genetic traits of a representative of the Globular amphora culture, among very few such DNA profiles available for a Neolithic person. Some of the alleles discovered are the oldest examples of particular alleles among those identified in human remains so far. DNA evidence suggests that the individual was lactose intolerant, and it demonstrates a genetic relationship with the Fertile Crescent. The analysis of stable oxygen isotope ratios shows patterns compatible with either residential mobility or weaning age. The analysis of stable

carbon and nitrogen isotope ratios allowed us to reconstruct the individual's diet; particular attention is drawn to the fact that up to 25% of his carbohydrate diet consisted of millet. This is the earliest isotopic evidence for the presence of millet in the diet of people living in Central Europe.

Keywords: Globular amphora culture; Neolithic; Poland; Kuyavia; ritual; sub-megalith

Introduction

At the end of the fourth millennium BC the Globular Amphora Culture, previously occupying fertile lands in the basin of the middle Vistula and upper Noteć rivers, began an extensive expansion. Materials characteristic for the Globular Amphora Culture appear at numerous sites in eastern Germany¹, northern Czech Republic², on the whole territory of contemporary Poland, and the western parts of Ukraine and Moldova³. Enclaves of this culture are known in Belarus, Lithuania, western Russia (Smolensk region) and western Germany. The Globular Amphora Culture is stylistically distinct from the other cultures of the period. This distinctiveness is visible in ceramic manufacture, the flint industry, treatment of bone, and use of amber. It also is evident in the ritual sphere. The most spectacular type of this culture's sites are sepulchral-ritual centers, consisting of objects containing human and animal burials (usually cattle). These tombs were often encased in stone structures of varying degrees of complexity, which is why in Polish literature they are sometimes referred to as "megalithic". However, since these structures were usually built from relatively small stones, a more appropriate term is "submegalithic tombs"⁴. The largest concentration of sepulchral sites with animal burials in Poland is in the region of Kuyavia – the supposed region of the Globular Amphora Culture's origin⁵. Recently, one of these submegalithic tombs was discovered and explored in Kowal (site 14). The results of these studies in conjunction with the results of analyses of archaeological material permit interesting observations regarding the time and functioning of the sepulchral-ritual centers of the Globular Amphora Culture and the rituals performed within their boundaries. The state of preserva-

tion of the uncovered organic materials enabled a series of paleobiological analyses, the results of which can greatly expand the current knowledge about life in the Late Neolithic.

The Kowal 14 site

The Kowal 14 archeological site is located northwest from Kowal, in the eastern part of Kuyavia Lakeland (central Poland) (fig. 1). Geographically, it is located on the morainic plateau that developed during the late Weichselian Glaciation; hydrographically, it is located in the lower Vistula River catchment area. The site lies on the flattest part of a slope edge of a so-called denudational remnant formed by the isolation of a part of slope flanked by two denudational valleys. It is the most developed form of this type in the analyzed part of Vistula River valley slope. The structure of soil cover around Kowal is typical for young glacial landscapes. The morainic plateau where the archaeological site is located, is occupied mainly by lessivé soils (Luvisols; according to IUSS Working Group WRB 2007) and black earth (Mollic Gleysols or Chernozems) as well as local gleyic soils (Gleysols) formed from glacial deposits. The black soils are the most fertile in the area, and it is presumed they could play an important role in the location and development of agricultural activities of Neolithic and subsequent groups of humans. The archaeological research at the site was carried out in summer 2007, prior to construction of Kowal's ring road. As a result of this research, one cultural layer and 377 cultural pits were documented.

Sepulchral-ritual place of the Globular Amphora Culture

A complex of sepulchral-ritual objects of the Globular Amphora Culture was discovered in the southern part of the site, at the top and slope of a small terrain hump, which from the northern side smoothly transforms into a hill, constituting a visible high edge. The distances between objects did not exceed 15 m (fig. 2). The complex included a submegalithic construction (obj. 208), a ritual object with animal burials (obj. 234), an accompanying fireplace (obj. 216), and a human burial (obj. 238).

The submegalith was oriented in the northwest-southeast direction and was 765 cm long and 510 cm wide. Remains of a stone structure emerged at a depth of about

1 Beier 1988.

2 Pleslová-Stiková 1981.

3 Sulimirski 1968; Szmyt 1999.

4 Beier 1991; Krzak 1994, 15.

5 Szmyt 2006.

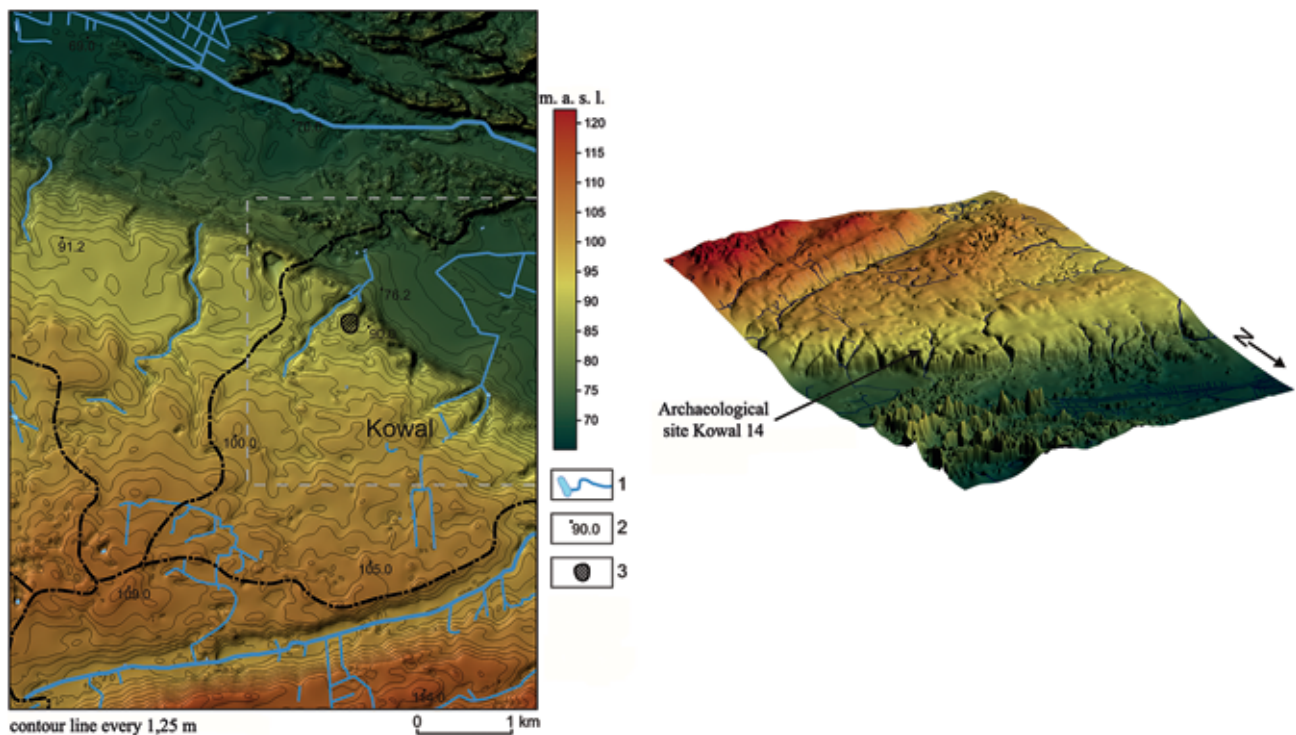


Fig. 1: Kowal site 14, commune Kowal. Localization of the site area. 1 – lakes and watercourses, 2 – altitude (m.o.s.l.), 3 – archaeological site Kowal 14 (Drawing: T. Górzyński, P. Weckwerth)

50 cm and was made of stones 80 cm wide (fig. 3). Larger stones were held in position by smaller unmodified cobbles. Presumably, the stone structure was originally built on a rectangular or elongated trapezoid, oriented on an east-west axis. Below 60 cm was a stone paving formed from loosely organized 10–20 cm stones. At a depth of 90 cm and lower at the floor of the submegalith, stones formed an even lower (second) level of paving, the range of which was restricted to particular pits. The submegalith was excavated to a depth of 150 cm and rich source material was extracted from it, including 2160 fragments and 1 whole piece of pottery (fig. 4,1–4), 40 flint artefacts, of which two were used as harvesting tools (fig. 4,5–6), and 5 stone artefacts. Also present were fragments of animal teeth (three of cattle and one porcine). The results of techno-stylistic analysis of the ceramics indicate that the submegalith was probably used for a very short time.

The ritual feature with animal burials (obj. 234) was a rectangular pit with dimensions of 160 × 430 cm, oriented on the east-west axis with a slight deviation of the western part towards north (fig. 5). Its boundaries were marked by a belt of burnt and overheated clay, around 10–20 cm wide. This most probably encased remnants of joists constituting a rectangular chamber made of oak (*Quercus* sp.) and pine (*Pinus silvestris*). In the eastern part of the object the burnt areas formed a kind of atrium, within which a

large ceramic pot was uncovered, probably an amphora (fig. 5). After removing the first mechanical layer (10 cm), the burnt layer was more intensive in the western and eastern parts of the object. At this level, animal remains were discovered, surrounded by small pebbles (approximately 16–30 cm) arranged nearly as a rectangle with dimensions of 130 × 260 cm, and oriented approximately on the north-west – south-east axis. The animal bones still present were in anatomical position, and they could be identified as belonging to a castrated bull, aged 34–42 months. In the north-west part of the object two teeth were found belonging to another individual (or two) significantly above the age of 4 years, and also a fragment of a damaged ceramic vessel, perhaps originally constituting funerary equipment. Additional and even better preserved animal remains were found at the bottom of the feature, exposed after removing another mechanical layer (the third stage of exploration). Results indicate that this animal was a female aged 29–32 months, which means that – as in the case of the animal from the higher level – its death occurred in the second half of the year (summer or early autumn). The type of deposition of both main animals, as suggested by the arrangement of the bones, was probably sitting⁶.

⁶ Makowiecki *et al.* i. pr.

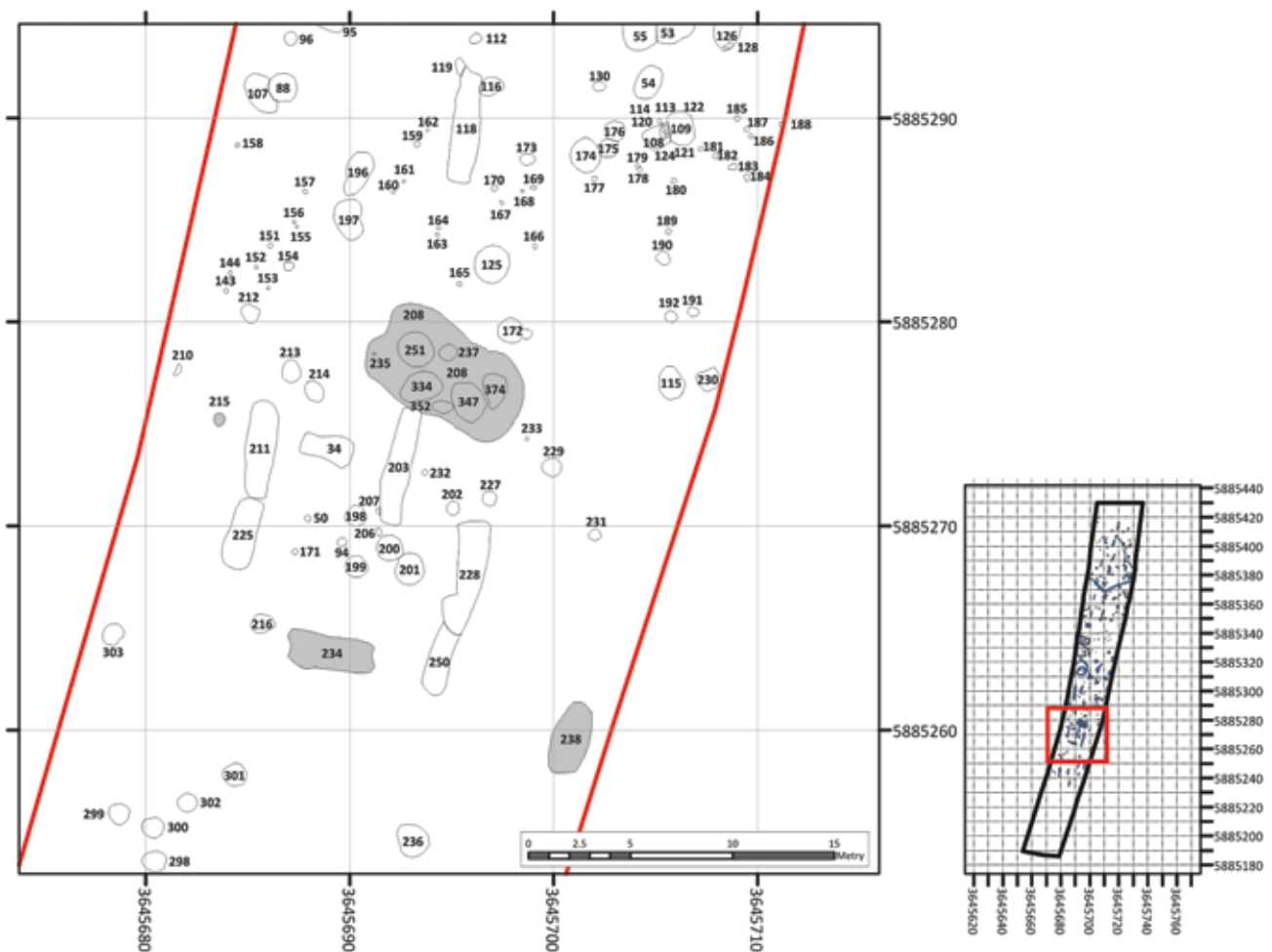


Fig. 2: Kowal site 14, commune Kowal. Central part of the site with archaeological objects (Drawing: T. Górzyński)

A human burial (obj. 238) was found, 367 cm in length and 188 cm wide. The cavity containing the bones was around 80 cm deep. The range of its bottom parts was delineated by pebbles of 10–20 cm in diameter, located at approximately every 20–60 cm. This formed an oval of dimensions 160 × 250 cm, in the middle of which was a well-preserved skeleton, belonging to a man at the age of *adultus* (between 25 and 35 years old). The body was placed in the tomb in such a way as to suggest it could have been tied up (for instance wrapped in cloth, possibly tied with rope) (fig. 6) and his death may have been sudden. Anthropological analysis revealed a comminuted fracture of the skull base. Also observed was a developmental anomaly of the individual's jaw bones and teeth that was visible in life, and probably distinguished this individual from other members of the group. It could also have led to differently intensified dyslalia (general speech defects) and possibly even the incorrect sounding of all phones – in effect, mumbling.

In the north-eastern part of the grave, about 25 cm from the skull, fragments of a pig's skeleton were discovered (lower jaw and left hindlimb, including femur, tibia and talus). Also found in the object were three ceramic vessels (fig. 7,1–3), a bone blade (fig. 7,4), a T-shaped ornamental element made of antler (fig. 8,1), a bone perforator (fig. 8,2), an unspecified bone tool (probably a chisel – fig. 8,3), a tool made from a boar's lower canine tooth (C_1) (fig. 9,1), a fragment of a smoothed bone tool, an axe of banded flint (fig. 9,2), a blade of chocolate flint (fig. 10,2) with use wear traces typical of perforating hides (fig. 10,2.a), a splintered core, a grinder stone (fig. 10,2) and a block of ochre.

Most of the tools carry clear signs of their use: grinding (fig. 7,4.a; 8,3.a; 9,1.a), polishing (fig. 9,1.b) and scraping (fig. 8,2.c; fig. 9,1.a). The perforator, fusiform blade and tool made of lower canine tooth (C_1) exhibit signs of use resulting from contact with meat or leather (fig. 7,4.b.c; 8,2.a.b; 9,1.b). On the flint axe, a secondary (recovery) cut was observed, which was probably made shortly

A



B

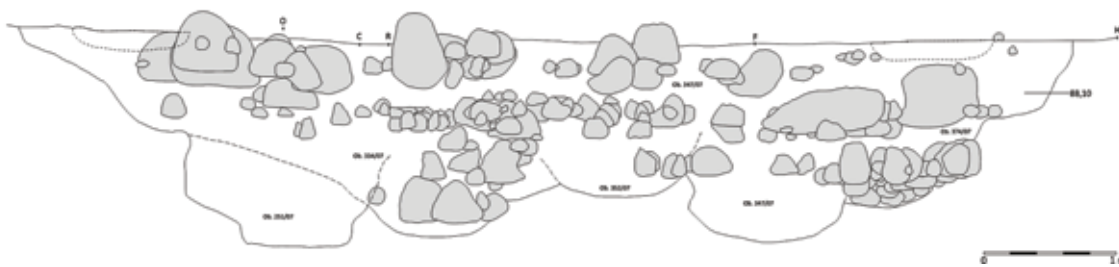


Fig. 3: Kowal site 14, commune Kowal. Submegalith (obj. 208): projection (A) and profile (B) of the megalithic construction (Drawing: A. Balonis-Chyb; Photography: G. Osipowicz)

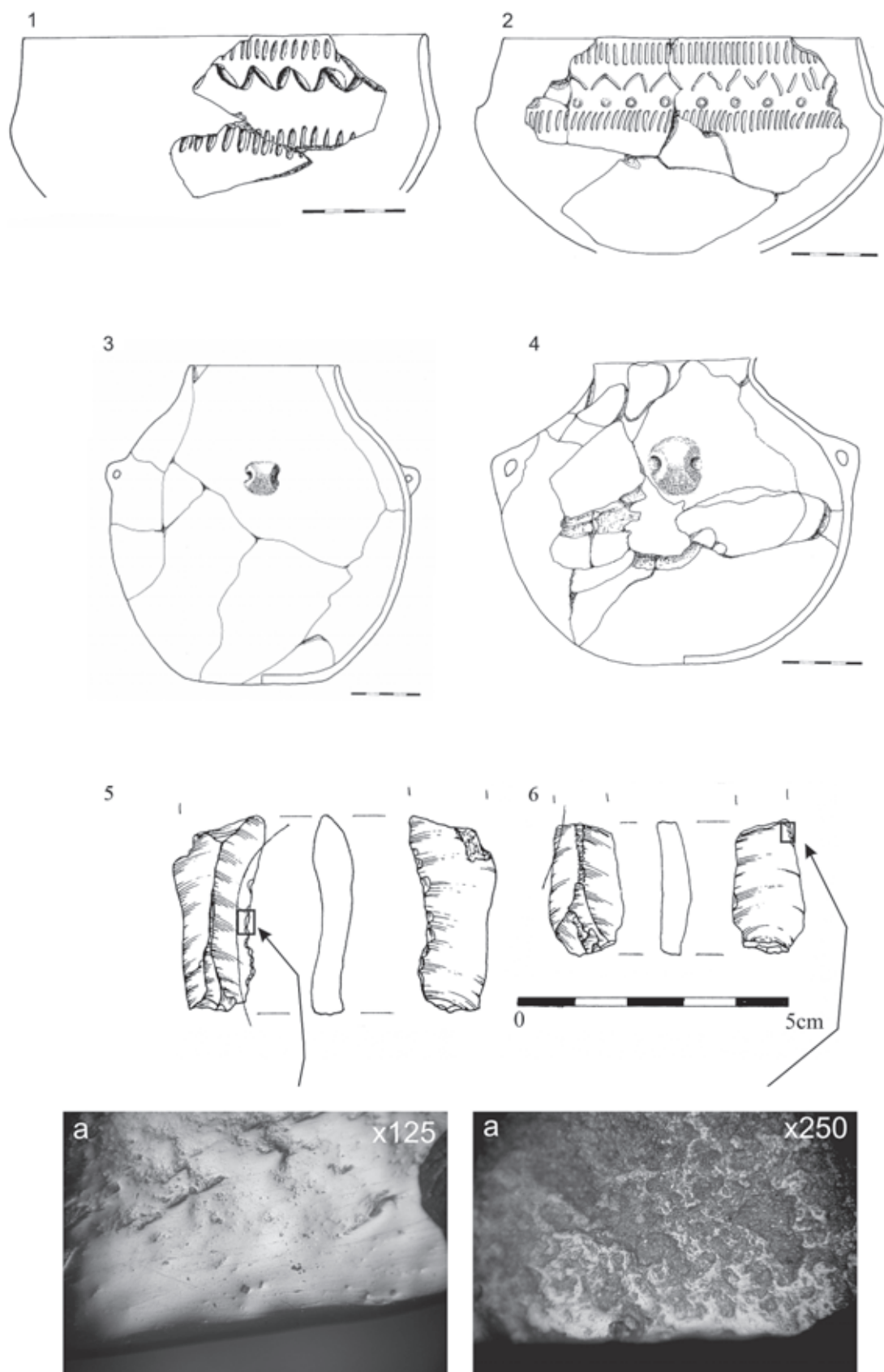


Fig. 4: Kowal site 14, commune Kowal. Submegolith (obj. 208): Pottery (1–4), flint artifacts (5, 6) (Drawing: D. Nowak [flints], B. Wawrzykowska [pottery]; Photography: G. Osipowicz)

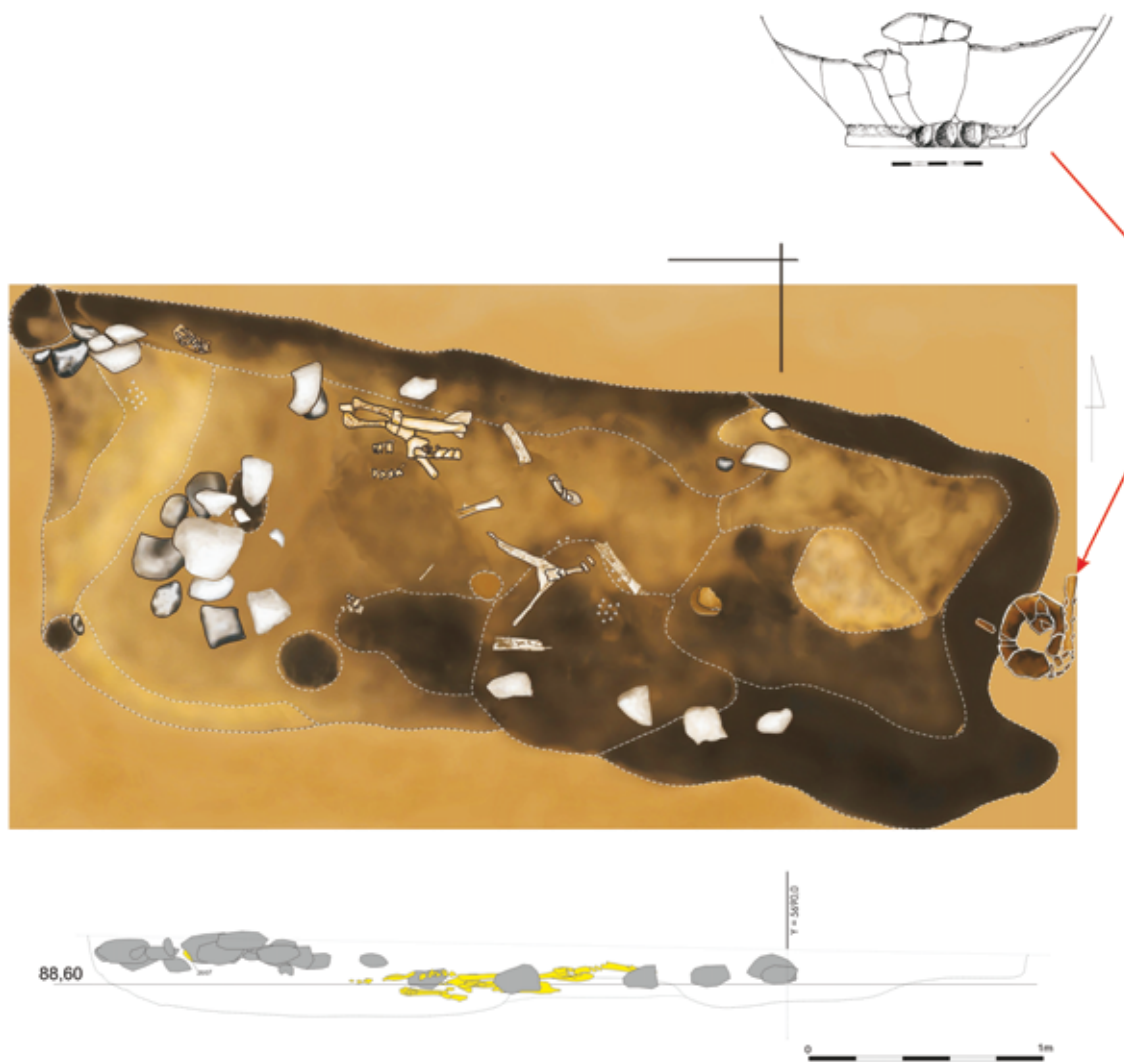


Fig. 5: Kowal site 14, commune Kowal. Ritual object with animal burials (obj. 234) (Drawing: A. Balonis-Chyb)

before putting the tool in the grave (fig. 9,1.c). This activity is perhaps an example of a ritual accompanying the burial, equipping the deceased with their own, fully functional (via refurbishing) working tools. The T-shaped ornamental element is made of two fragments of deer antler, which after deliberate shaping, were joined using a type of lime mortar (the oldest of such binders in this part of Europe⁷).

Human remains found in the object 238 were subjected to anthropological analysis as follows. Their results will be presented here only as an outline (independent publication regarding only these subject is in preparation⁸).

Stable oxygen isotope ($\delta^{18}\text{O}$) analysis was conducted using a fragment of a femur and enamel and dentine of permanent teeth (second incisor, first premolar and first molar). A porcine bone, found by the skeleton, was used as a reference material, representing the local isotopic baseline. The human teeth showed a decrease in $\delta^{18}\text{O}$ by 1–3 ‰ in the enamel of the first premolar ($\delta^{18}\text{O} = 22,21$ ‰), the dentine of the second incisor ($\delta^{18}\text{O} = 23,74$ ‰) and the femur ($\delta^{18}\text{O} = 20,86$ ‰) relative to samples taken from dentine of the first molar ($\delta^{18}\text{O} = 24,95$ ‰) and enamel of the second incisor ($\delta^{18}\text{O} = 25,23$ ‰). The level of $\delta^{18}\text{O}$ of the porcine bone amounted to 21,65 ‰, a value taken to represent a local environmental baseline.

Stable nitrogen and carbon isotope analysis was conducted from collagen of a rib. The $\delta^{13}\text{C}_{\text{coll}}$ and $\delta^{15}\text{N}$ values were $-20,3$ ‰ and $9,9$ ‰, respectively. Carbon from bone mineral of the same rib exhibited a $\delta^{13}\text{C}_{\text{ap}}$ value of $-11,22$ ‰.

⁷ Rumiński/Osipowicz 2014.

⁸ Kozłowski *et al.* i. pr.

KOWAL, commune Kowal, site 14

Excavation:

Ar 5250/5690 B

Ar 5250/5700 A

Ar 5260/5700 D

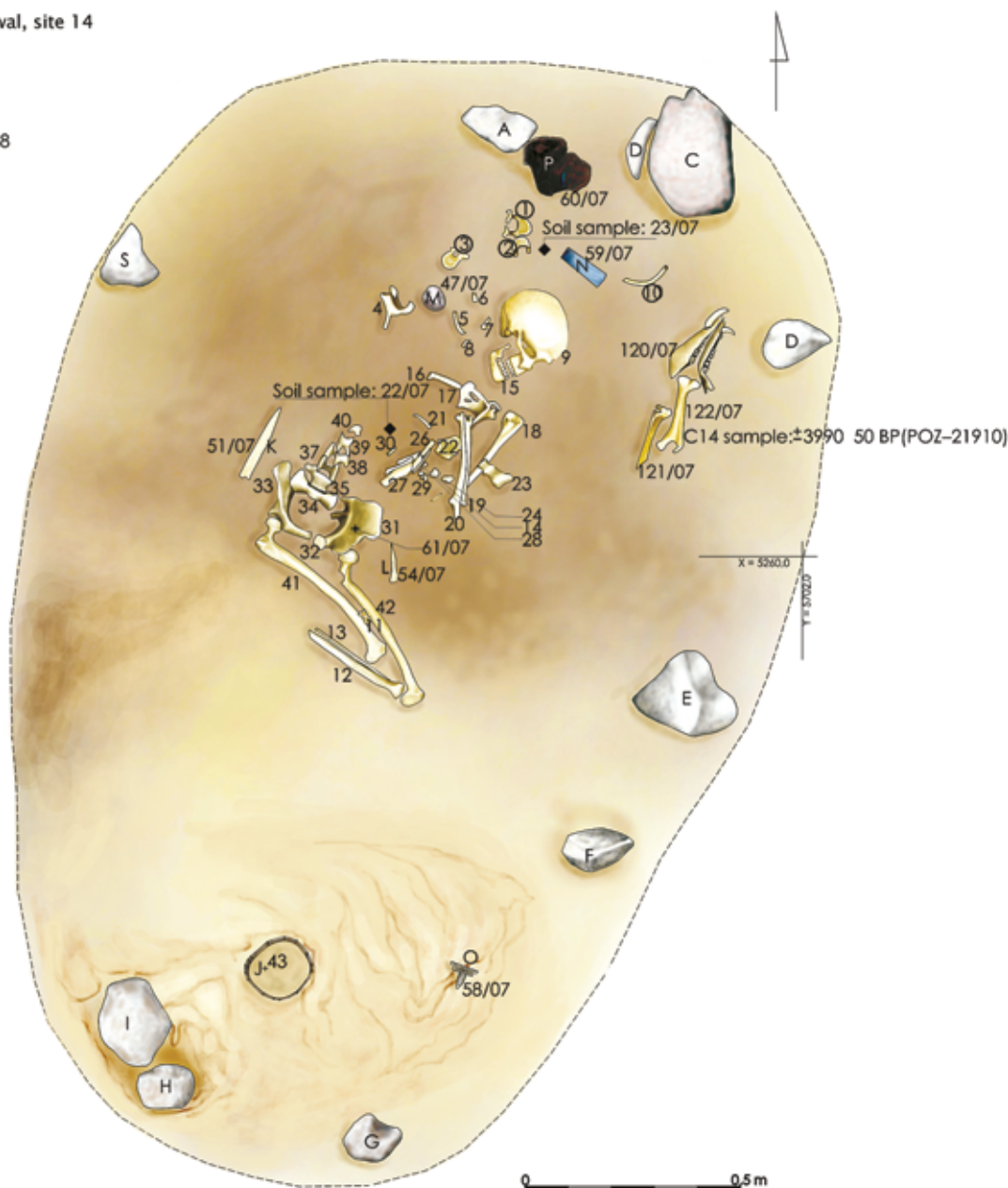
Projection of object 238

Scale 1:10

Draw. A. Balonis

Altitude:

- 1 – 87,69
 2 – 87,69
 3 – 87,67
 4 – 87,65
 5 – 87,67
 6 – 87,67
 7 – 87,67
 8 – 87,67
 9 – 87,81
 10 – 87,69
 11 – 87,65
 12 – 87,63
 13 – 87,62
 14 – 87,66
 15 – 87,76
 16 – 87,70
 17 – 87,70
 18 – 87,70
 19 – 87,69
 20 – 87,69
 21 – 87,66
 22 – 87,69
 23 – 87,67
 24 – 87,68
 25 – 87,68
 26 – 87,69
 27 – 87,68
 28 – 87,69
 29 – 87,69
 30 – 87,69
 31 – 87,68
 32 – 87,69
 33 – 87,75
 34 – 87,74
 35 – 87,74
 36 – 87,67
 37 – 87,67
 38 – 87,67
 39 – 87,66
 40 – 87,66
 41 – 87,69
 42 – 87,64
 43 – 87,74
 A – 87,73
 B – 87,76
 C – 87,85
 D – 87,82
 E – 87,77
 F – 87,81
 G – 87,94
 H – 87,89
 I – 87,76
 J – 87,59
 K – 87,56
 L – 87,62
 M – 87,67
 N – 87,65
 O – 87,61
 P – 87,68
 R – 87,68
 S – 87,75
 120/07 – 87
 121/07 – 87
 122/07 – 87



C14 sample from bone number 44/07

4105 ± 35 BP (POZ-21912)

①②③④ bones mixed during exploration

Fig. 6: Kowal site 14, commune Kowal. Human burial (obj. 238) (Drawing: A. Balonis-Chyb)

DNA was isolated from two molars. The sequencing of the product of amplification of the 13 intron of gene *MCM6* indicated the presence of two copies of C_{13910} allele. Also, two copies of wild allele of the *CFTR* gene (chromosome 7) and two copies of wild allele of the *CCR5* gene (chromosome 3) in the genome of the individual were identified. The analysis of mtDNA allowed identification of an alter-

ation at 16224, 16311 (within HVR I) and 73, 146 and 152 (within HVR II) positions in comparison to the reference sequence (CRS) indicating that the studied individual belonged to the haplogroup K2a (HaploGrep).

Paleoserological research was performed on 8 bone samples and 4 teeth. The majority of performed analyses reaction of antibodies anti-B with antigens B was repeated,

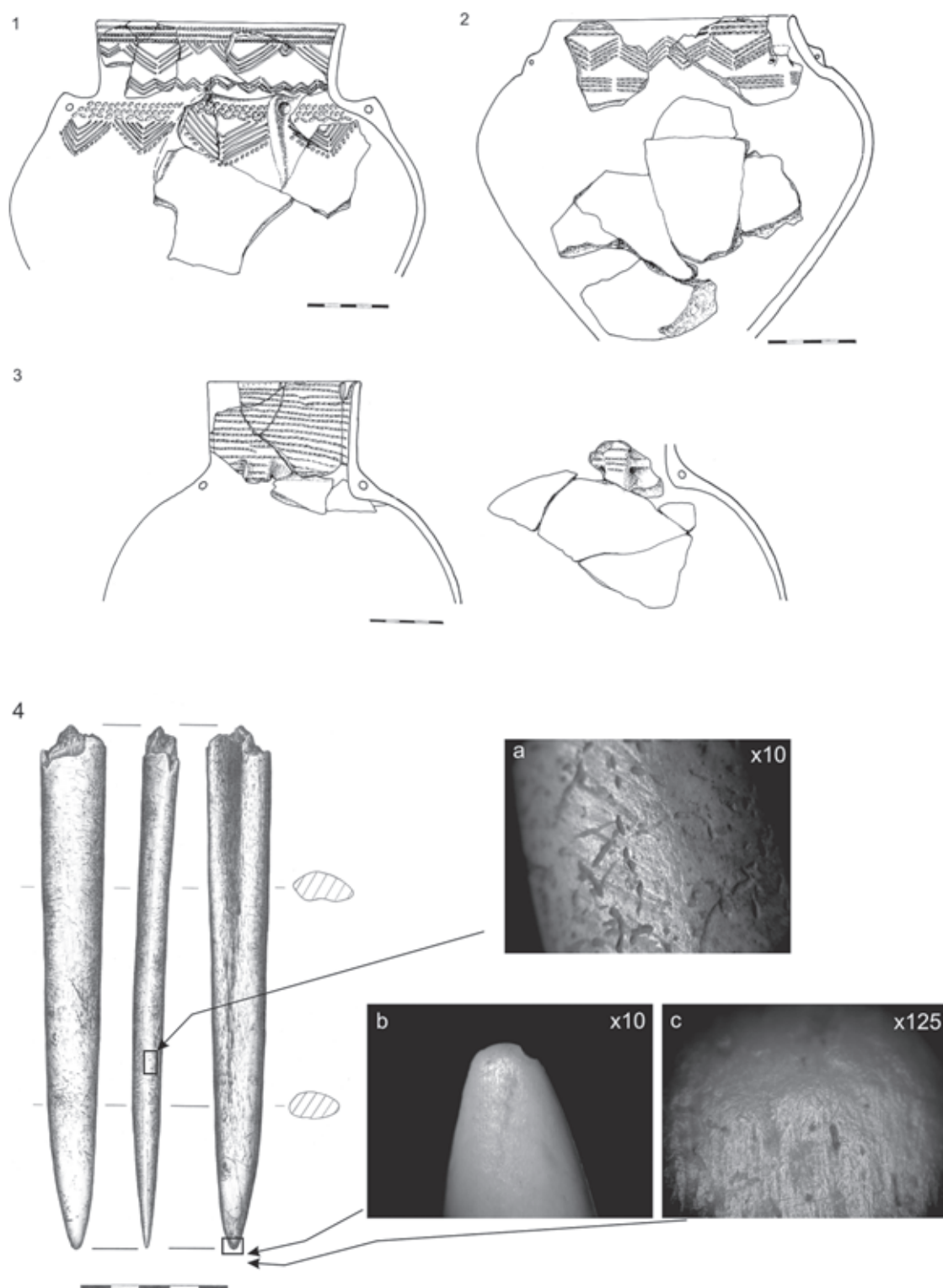


Fig. 7: Kowal site 14, commune Kowal, object 238. Pottery (1–3), bone blade (4)
(Drawing: B. Wawrzykowska [pottery], B. Kowalewska [bone]; Photography: G. Osipowicz)

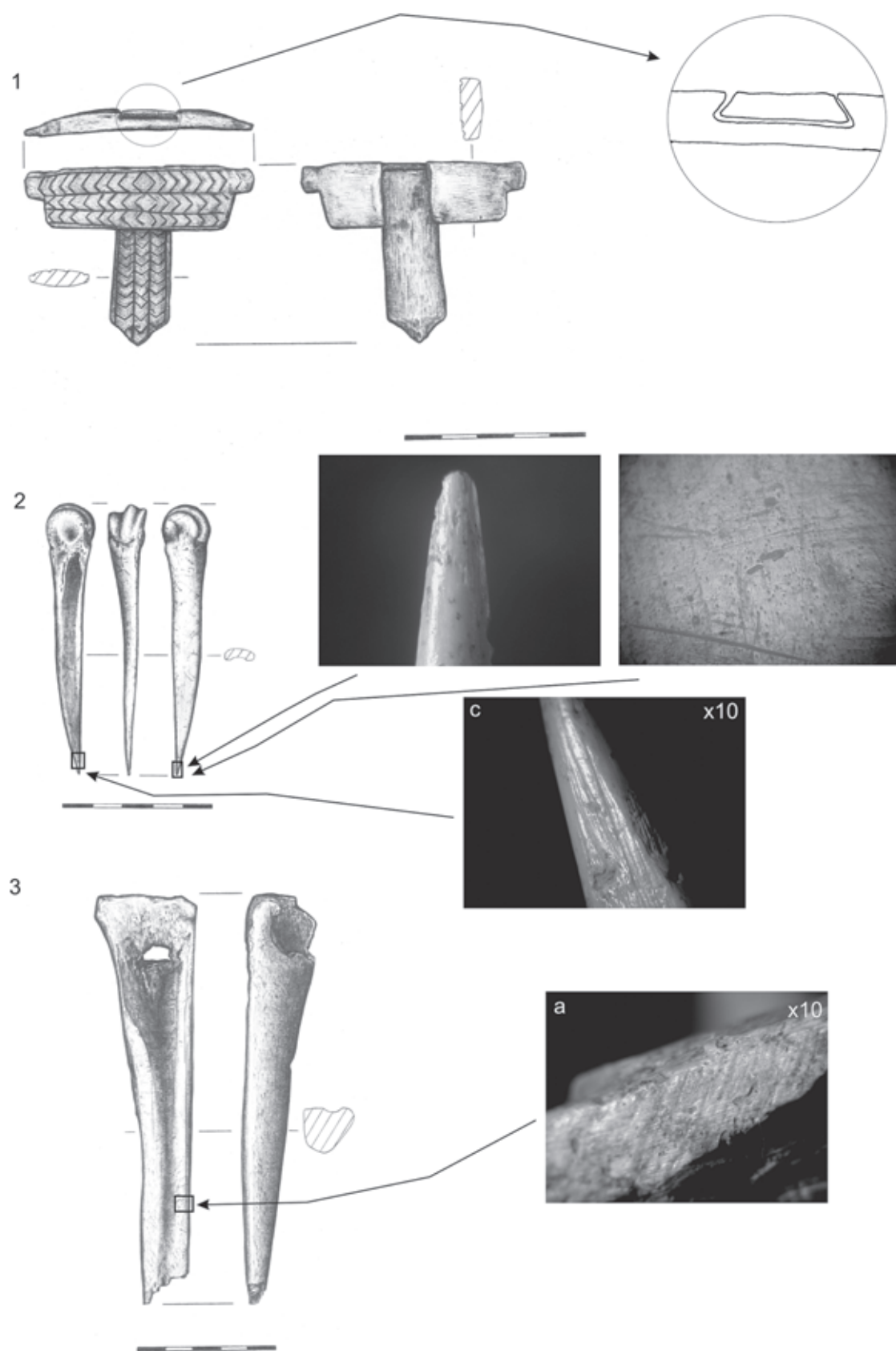


Fig. 8: Kowal site 14, commune Kowal, obj. 238. Burial equipment made from bone and antler: T-shaped ornamental element (1), perforator (2), probable chisel (3) (Drawing: B. Kowalewska; Photography: G. Osipowicz)

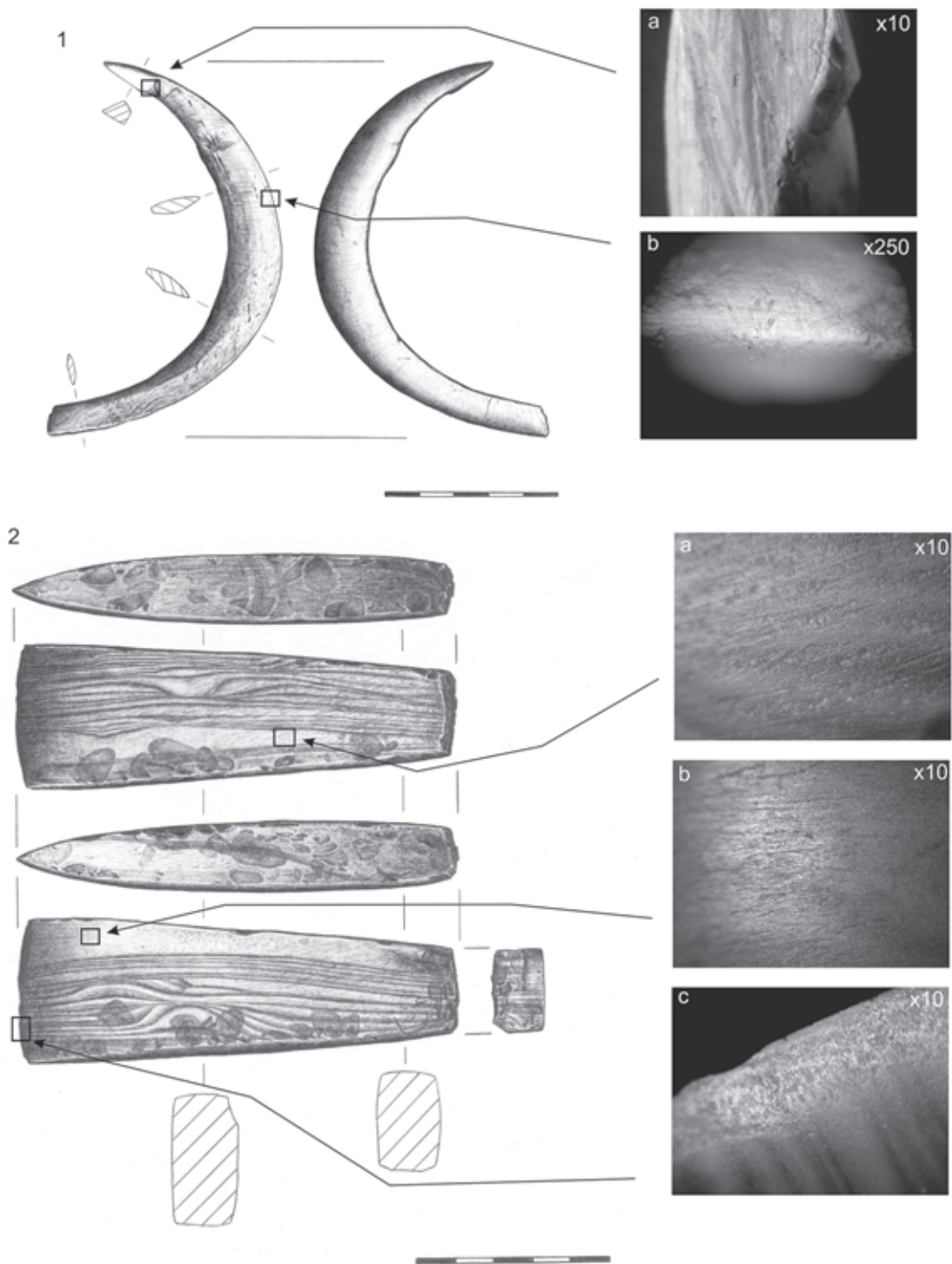


Fig. 9: Kowal site 14, commune Kowal, obj. 238. Burial equipment: a tool made of lower canine tooth (1), flint axe (2) (Drawing: B. Kowalewska; Photography: G. Osipowicz)

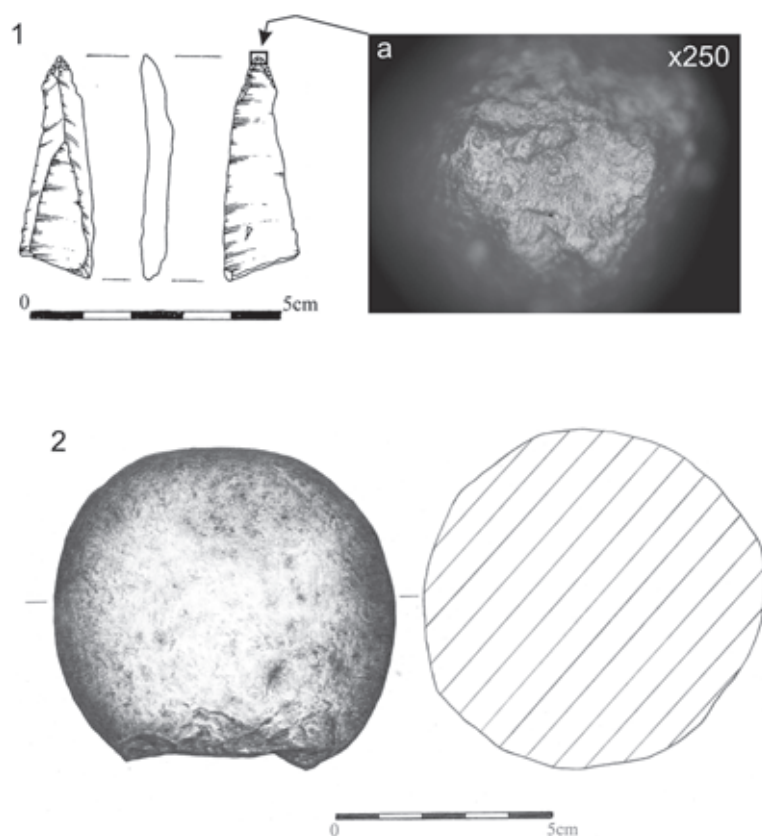


Fig. 10: Kowal site 14, commune Kowal, obj. 238. Burial equipment: flint blade (1), stone grinder (2) (Drawing: B. Kowalewska; Photography: G. Osipowicz)

which indicates that the studied individual carried blood group B.

During the excavation of the sepulchral-ritual place discovered in Kowal a number of samples were taken for ^{14}C dating from which 6 dates were obtained (two for each object – Tab. 1). They indicate that most of the described materials should be associated with the classical horizon of the Globular Amphora Culture development, i.e. the period attributed to the phases IIb (3250/3100–2900/2700 cal BC) and IIIa (2900/2700–2400/2150 cal BC) in Kuyavia⁹. Undoubtedly, both human (obj. 238) and animal (obj. 234) burials date to this time frame. Their radiocarbon dates are corroborated by the typological analysis of historical materials. Problematic, however, is the chronology of object 208. One of its ^{14}C dates (3030–2910 cal BC) falls within phase IIb of the Globular Amphora Culture development in Kuyavia. Such is also the chronology of the majority of cult objects of this culture known from this region. The second date obtained for this object (3640–3370 cal BC) places it in phase IIa (3700/3450–3250/3100 cal BC).

From the above information, two possible formation sequences of the complex can be posited:

- first a submegalith – then an object with animal burials – finally, a human grave,
 - first a submegalith and an object with animal burials – finally a human grave,
- Two other possible sequences are:
- first a submegalith – then an object with animal burials + a human grave,
 - all the objects functioned at the same time, have been excluded by the results of ^{14}C dating.

It should be noted, however, that the inference may contain some errors due to the nature of the dated samples, for clear is a difference between results obtained for charcoal (older) and bone (younger) samples (Tab. 1). It is perhaps due to real chronological differences. Other factors, however, cannot be excluded, e.g. the employment of the “old wood” in wooden constructions, or occurrence of false results of bone sample dating. More and more often attention is drawn to issues with ^{14}C dating results obtained for bones, and clear discrepancies between then and results of dendrochronology and dating of charcoal¹⁰. It is believed that they may be due to the diet of dated animals (as well as humans), which could significantly

⁹ Szmyt 1996.

¹⁰ Denaire 2009.

Tab. 1: Kowal, site 14.¹⁴C dating of Globular amphora culture artefacts (calibration in OxCal 4.1, version 2011)

| Feature no./sample no. | Lab. code | BP date | 1 σ probability | Type of sample |
|--------------------------|-----------|---------------|--|----------------|
| Feature208/ no. 63/07 | Poz-21970 | 4370 \pm 40 | 3022–2919 BC – 68.2 % | Charcoal |
| Feature208/ no. 66/07 | Poz-21969 | 4710 \pm 40 | 3627–3592 BC – 18.0 % 3527–3498 BC – 15.9 % 3437–3378 BC – 34.3 % | Charcoal |
| Feature234/ no. 75/07 | Poz-21911 | 4300 \pm 50 | 3010–2980 BC – 15.1 % 2958–2951 BC – 2.6 % 2941–2881 BC – 50.5 % | Cattle bone |
| Feature234/no. 40/07 | Poz-21959 | 4450 \pm 35 | 3322–3236 BC – 31.1 % 3171–3162 BC – 2.8 % 3116–3079 BC – 14.4 % 3071–3025 BC – 19.9 % | Charcoal |
| Feature238/no. 44/07 | Poz-21912 | 4105 \pm 35 | 2849–2813 BC – 16.2 % 2741–2730 BC – 4.3 % 2694–2687 BC – 2.4 % 2679–2580 BC – 45.3 % | Human bone |
| Feature238/no. 122/07 | Poz-21910 | 3990 \pm 50 | 2575–2467 BC – 68.2 % | Pig bone |

influence presently obtained results¹¹. Thus, isotope studies carried out can help solve the problem in the future.

Interpreting the results

The results of the geomorphological, geological and soil analyses suggest the location of the Kowal 14 site is not accidental, but rather that it was deliberately chosen. The studied cluster of objects is located at a clear morphological border zone between Kuyavia Lakeland (morainic plateau) and Płock Basin (a part of lower Vistula River valley). The site is situated on the highest and distinctive (upper) section of a slope. In addition, it is located on one of the best developed denudation remnants in the vicinity of Kowal. Also important from the point of view of the site location is the fact that it is surrounded from the north by a small valley, which at the time of the Middle Neolithic might have been drained by a small watercourse.

The building of the ritual object with the submegalithic construction started with digging a pit in a rectangular shape approximately 7 m long, 5 m wide and not exceeding 80 cm in depth. At its bottom 5 smaller pits of up to 1 m in diameter and depth of up to 50 cm were dug beside one another, forming an arch with arms directed towards the north. The bottom of the object exposed

towards the east was inlaid with three layers of compact stone paving. Small stones were also discovered in the remaining objects, but these did not form such compact structures. Infill analyses indicate that all the pits were used simultaneously (or within short time intervals) for a very short time. Taking into account the preserved animal remains (mainly cattle teeth), one may suggest that ritual practices were performed here, perhaps related to deposition of fragments of animal carcasses. Undoubtedly, the rituals were accompanied by a deposit of ceramic vessels. The presence of two harvesting tool inserts is enigmatic, as these were the only functional tools discovered in the object. Perhaps their importance goes beyond the purely utilitarian sphere. After the completion of whatever rituals may have occurred, the objects were filled with soil originating probably from their original infill, as it is virtually free of any cultural substrate. The period between the completion of rituals and the refilling of the objects must have been short, because no traces of washout or free-filling of the infill were identified. The pits were sealed with loose paving stone, which was in turn covered with a 20 cm layer of soil. This soil was of a different origin than that used to fill the objects. It contained a large amount of humus and fragmented artefacts, suggesting the original humus horizon (A) was the source of this material. This was confirmed through soil analyses. It was on this layer that the submegalithic structure was placed. Some stones forming it were positioned with supports. The space between the stones was filled with the same soil used to cover the second paving layer. The initial stage of

¹¹ Cook *et al.* 2001; Petchey *et al.* 2011; Ramsey 2008, 253 f.

submegalithic construction backfilling remains unclear. However, the submegalith was probably quite clearly visible for some period of time, as evidenced by the deposits of Corded Ware Culture vessels found at the base of larger stones.

At the time of discovery, the ritual object with animal burials (obj. 234) was significantly damaged. This limits interpretations of its original design and of the nature of activities performed here. Nevertheless, it was possible to make several interesting observations about its structure, especially regarding the organization of the ritual space. The object was a complex construction, within which several usage zones may be distinguished (fig. 5). Its boundaries were marked by a rectangular wooden chamber oriented with respect to the four cardinal directions. Currently, it is difficult to discern its original construction, but it was certainly at least partially immersed in the ground. The western part of the chamber might have been roofed, which is suggested by the presence of several small cavities filled with burnt material in the outer parts of the objects, likely the remains of postholes, and a layer of burnt material in the middle of the object, perhaps remains of the roof itself. A possible roof marked an area of around 2 m², in which the dominant role was played by the object of about 80 cm diameter, made from small stones and arranged in several layers. It lays higher than other parts of object and it is the only registered trace of usage of this zone of construction. In this region no bones, ceramics, or other remnants of human activity were found. Another usage zone of the object was marked by a surrounding zone of stone, made of loosely arranged small cobbles. It delineated a nearly rectangular area of dimensions 210 × 120 cm, the eastern side of which may be described as open (no stone surrounding occurred here), while the western side was closed by the paving mentioned above. The area could be interpreted as a sacrificial space in which animal bodies and equipment used in the rituals were deposited. It is essentially the only part of the object in which bones occurred. East of this zone, outside the stone surrounding, is another probable usage zone. This area (approximately 90 cm in length) was closed with the beams of the outer wall of the object. In this region no prehistoric mobile artefacts were identified, but an exceptionally large amount of burnt sediment and humus was discovered. There may be a variety of explanations for this, but it is probable that a wooden construction was located here in the past, and collapsed into the object (which seems to be confirmed by the profile of layers). Taking into account a large degree of saturation with organic material it is possible this might have been something more than just a part of the outer chamber; it might have had a closed

structure, which could partly explain the lack of any artefacts in this part of infill. A more precise interpretation of its existence is, however, impossible due to insufficient data. The last discernible usage zone of the construction is located on the eastern edge and is distinguished by the beams, which formed here a kind of vestibule. As already mentioned, remnants of a large amphora were discovered here. This region could be considered a gift-making zone, with the amphora representing an offering. Also associated with the amphora was a small fireplace, located in its immediate vicinity to the west.

The faunal deposit discovered in the object consisted of partial cattle skeletons, perhaps of three or even four individuals (two intact bodies and two teeth). There are two deposits which have much in common, particularly the same cardinal orientation of animals and traces of ritual and/or processing activities, the effect of which was leaving the same parts of the animals intact, i.e. their haunches, while the remaining parts were scattered over the utilized space. However, significant differences between the two deposits were also identified. Taphonomic evidence suggests a few interpretations regarding the stages of deposition of these animal remains. Most of the recovered long bones, parts which were found on the second exploration level, were characterized by a low degree of weathering, which according to the six-degree scale of Behrensmeyer¹² may be described as from 0 to 1. This means that the bones were quickly covered with sediment, and if they were subject to the process of atmospheric weathering, it was for no longer than three years. The degree of weathering and fragmentation of materials found in bottom parts of the object (third exploration level) was clearly less than that of the bones from the higher level. In the six-degree scale they reached values of 2 and 3, suggesting the weathering process lasted for 2–4, and maybe even 4–8 years¹³. It may be that remains from the different levels were subject to cultural/ritual factors that were only the same in some respects, and that the materials from the higher level underwent degradation for shorter time than those lying in the bottom of the object.

To summarize these interpretations, and greatly simplify the matter, one might, using terms of modern religious studies, go so far as to make a mental shortcut and hypothesize that the described construction may have been a kind of a small “temple”, in which the ritual zone was located in a rectangular wooden construction. The western (perhaps covered) part of the object may have served the function of a “sacrum”, in which an important

¹² Behrensmeyer 1978.

¹³ Ibid.

role was played by stone paving located here. The ritual (sacrificial?) space was separated by a surrounding area of cobbles, and the role of “relic/sacrifice” was played by animals buried here (probably intentionally killed). The object was open to the east, where the “gift-giving zone” was located. Associated with the rituals performed here was a construction primarily of wood, perhaps playing the role of a small “altar” or stairs/ramp through which animals (or parts of their bodies) were brought down. Rituals in the object were performed at certain seasons of the year, in late summer or late summer/early autumn. The available evidence suggests that two main rituals took place here, separated by a break of at least several years. However, one cannot rule out the possibility that in the period between them the object was used for other practices. During both the main rituals, parts of bodies of young animals were deposited (in one case probably a castrate; in another, a cow). Both deposits have common characteristics, suggesting they were formed in a similar manner. The type of deposition of the animals may result from the nature of the rituals. One probable hypothesis is that the animals were brought into the feature complex alive, where they were ritually killed and left there, bordered by the walls of the timber structure. The fragmentariness of the skeletons’ preservation and a similar anatomical content of the deposits indicate that some (particular) parts of their bodies might have been separated after death and, for instance, consumed during rituals. The moment of deposition in the object constitutes a time point after which treatment of the animals differed. The animal identified in the deeper level of the object was not covered with soil (at least not completely) and was perhaps subject to the influence of atmospheric conditions for several years, suggested by the degree of weathering and dispersed arrangement of its bones. Prior to the second ritual, the space was probably cleaned. Some of the bones of the first individual, already in a “loose” state, were removed. Other parts were covered, either during the ritual or by sediment accumulating after the object was no longer enclosed. Next, the second animal was deposited, to be covered with soil relatively quickly. It is unknown for how long the described ritual deposition functioned. However, it is certain that at some time point the structure was destroyed by fire.

The third identified object (a human grave) was a one-time deposition of very simple construction, although the dimension of the grave chamber exceeded the needs resulting from burial size and equipment. The arrangement of the body indicates that it may have been put in the grave tied up. Analysis of the grave equipment showed that it was carefully prepared to be a gift, confirming its

significance in the funeral rite. Noteworthy is the very precise (hence probably ritual) repair of tools for daily use, observed in the case of the axe made of banded flint, and the bone pointer found in the grave.

The grave was filled directly after the burial, an interpretation supported by the state of preservation of the remains. The soil used to in-fill the grave was deliberately mixed with calcium carbonate, originating most probably from outside the area of the site, which serves as another indication of funeral practices. Also thrown into the infill was a large ochre concretion, the meaning of which remains unclear. Perhaps the colors of both the substances (calcium carbonate – white, ochre – bright red) were important, symbolizing, for instance, bones and blood¹⁴. It is likely that the individual in this grave was a person important within the local Globular Amphora Culture society, evidenced by the quantity and quality of the funerary equipment. There may be other interpretations, however, particularly on account of the unusual pathologies exhibited by this individual. Traces of the comminuted fracture of the skull base (so-called broken neck) indicate the young man buried here might have been the victim of a ritually motivated murder. Such an interpretation is supported by the presence of a fusiform blade in the grave, considered to have been used for ritual killing of animals and people¹⁵. If the death of this individual served a ritual purpose, it may be speculated that his selection as the victim was not random. He might have been chosen because of his probable ailment – a highly developed speech defect – resulting from morphological features of his skull which would have distinguished him from other people. However, one cannot decisively rule out his death as resulting from an accident (e.g. falling from a height), or the possibility that the fracture occurred post-mortem through rough handling of the body.

Wear on some of the grave goods indicate that they were previously used and may perhaps be interpreted as related to the activities carried out by the individual in his lifetime. Three tools (including two perforators made of flint and bone and a tool made of a lower canine tooth) show signs of a long-term work with leather. The fusiform blade may also be directly associated with “treatment” of animal carcasses. No other artefacts of functional purpose were found alongside the human remains. It is likely that animals played an important role in this individual’s life, including the possibility that he was occupied with animals on a daily basis (e.g., tending herds). Even more information about this man’s origin and life are provided

¹⁴ Woźny 2005.

¹⁵ Nosek 1967; Krzak 1994.

by paleobiological analyses. At the outset, the successful attempt to determine the blood group of an individual living 4 thousand years ago on the basis of biochemical analyses of his bones is noteworthy. This is the first such successful attempt in the history of European Neolithic research. Similarly significant, this DNA analysis provides the first reported description of genetic traits of a Globular Amphora Culture individual from Kuyavia, and is one of few such studies concerning people living in the Neolithic in general. The DNA analyses have yielded the oldest examples of alleles *CCR5*, *PRNP* and *CFTR* in human remains to date. Identification of the -13910 C allele of the *MCM6* gene in remains from the Vistula river basin dated for 4105±35 years BP (Poz 21912) (Tab.1) confirms the individual was lactose intolerant. Evidence for the activity of lactase, an enzyme digesting lactose, has been previously reported in the earliest representatives of the European Neolithic, i.e. the Linear Pottery Culture, describe only of -13910 C alleles¹⁶, however, the simulation of the profile of -13910 C/T SNP spreading implies the presence of the -13910 T allele in early-Neolithic populations¹⁷. The presence of the identified mtDNA haplotype seems to indicate that the individual was related to people of the first European Neolithic cultures, at least in maternal lineage, since the haplogroup K was found as one of five the most abundant among LBK representatives (H, HV0, J, T, K) in contrast to U5a and U5b which dominated among hunter-gatherers studied until now¹⁸.

Differences in the $\delta^{18}\text{O}$ values among the teeth of this individual might indicate a change in residence during his lifetime, perhaps around the age of 3–4 years. In Europe, towards the north-east into the continent, baseline $\delta^{18}\text{O}$ values decrease. High $\delta^{18}\text{O}$ values are recorded near the Atlantic Ocean and the Mediterranean basin¹⁹. It is known that the Globular Amphora Culture settlement reached deep into Ukraine covering Volhynia and Podolia, and its representatives reached even Moldova, which are areas with high $\delta^{18}\text{O}$ values. Thus, one cannot exclude the possibility that individuals of this culture moved large distances, particularly if we assume that journeys took place in the “acquainted” zone, i.e. covered by the settlement of culturally close groups. On the other hand, it is known that a decrease in $\delta^{18}\text{O}$ values during life may be associated with weaning²⁰. A decrease of the $\delta^{18}\text{O}$ signature of this individual through time may indicate that

through age 3 or 4, mother’s milk was a significant source of water/food, serving at the same time as an immunity increasing factor. The idea that a child’s diet consisted of non-maternal food, while mother’s milk replaced or supplemented drinking water, seems probable. Prolongation of weaning even to the 4th – 5th year is often encountered in past populations²¹. It is believed that this practice is intended to protect offspring against pathogens present in surface waters, these being the primary source of drinking water, and to provide passive immunity for as long as possible²². Both interpretations of the $\delta^{18}\text{O}$ data (mobility and weaning) are interesting, and not mutually exclusive. This issue is likely to be resolved only by analyses of strontium isotopes which are planned for the future.

The results of stable carbon and nitrogen isotope analyses are also important. The $\delta^{13}\text{C}_{\text{coll}}$ and $\delta^{15}\text{N}$ values indicate that the individual’s primary protein source was terrestrial animals. In general, $\delta^{13}\text{C}_{\text{coll}}$ and $\delta^{15}\text{N}$ values in people are greater by 1‰ and 3–5‰ respectively than the values of animals forming the basis of their diets²³. If pigs, cows and deer from some Neolithic sites in southern Germany are used for comparison²⁴, the studied individual’s values are consistent with these expected diet-tissue spacings and a diet of terrestrial animals. The presence of pigs and cows as a major source of proteins in a GAC representative fits perfectly with the common knowledge about this culture²⁵, but also with information collected as a result of the analysis of grave’s equipment. The fact that the analyzed individual did not tolerate lactose suggests the animal protein in question was meat (or blood) and not dairy. The $\delta^{13}\text{C}_{\text{coll}}$ value is somewhat lower and the $\delta^{15}\text{N}$ value somewhat higher than medieval Polish populations²⁶, possibly suggesting consumption of freshwater fish in small amounts.

Analysis of $\delta^{13}\text{C}$ values from apatite (picturing the diet as a whole) showed a diet based on C_3 cereals but also possibly containing up to 25 % of millet, a C_4 plant. This is the earliest reported isotopic evidence for millet’s presence in human diet in this region of Europe. Taking into account the potentially high contribution of millet to the overall diet, one should consider if our knowledge of the role of this cereal in the Late Neolithic of the referred area adequately reflects the actual prehistoric situation.

¹⁶ Burger *et al.* 2007.

¹⁷ Gerbault *et al.* 2011.

¹⁸ Haak *et al.* 2010.

¹⁹ West *et al.* 2010.

²⁰ Wright/Schwarcz 1999; White/Longstaffe/Law 2004.

²¹ Wright/Schwarcz 1999; Choy *et al.* 2010.

²² Walker *et al.* 2009.

²³ Drucker/Bocherens 2004; Schoeninger 1989.

²⁴ Dürrewächter *et al.* 2006.

²⁵ Wiślański 1969; Szmyt 1996.

²⁶ Reitsema/Crews/Polcyn 2010; Reitsema 2012.

Considering $\delta^{13}\text{C}$ data from both collagen and carbonate together placed the studied individual among the representatives of populations whose diet was based primarily on “fruits of the earth.” Similar values were obtained for people living on the area of Greece and Anatolia in the Neolithic²⁷ as well as in Siberia during the Neolithic and Bronze Age²⁸.

Conclusion

The sepulchral-ritual place discovered at site in Kowal is unique for many reasons. First of all it seems that the classical understanding of sites of this type as cemeteries composed of objects containing one-time deposits requires reevaluating. They were rather a place of long-term cult practices²⁹, that played similar functions as the extended megalithic constructions in Western Europe. Analyses revealed that rituals performed in Kowal were of complex character. Probably for the first time clear evidence was found that individual acts of animal sacrifice and deposition in this kind of object could be separated by an interval of just a few years. Equally important was a chance to notice that the infill structure of certain pits shows a very accurate organization of the sacred space and a possibility of distinguishing even a few utilitarian/ritual zones within them. Very important information was provided by the study of a human burial discovered at the site. There is possibility that in this tomb, a deliberately chosen victim of a ritual murder was buried, perhaps coming from the tribal “aristocracy”. The analysis of the grave equipment revealed its ritual nature as a gift, and suggested a dominant role of animals in the deceased individual’s everyday life. Important data were obtained through the paleobiological study of the individual’s bones. Paleoserological analysis revealed the blood group of the buried individual, and is the first such case in the history of the European Neolithic research. The results of DNA analysis are the first description of genetic features of a representative of the Globular Amphora Culture in the literature, and some of only a few concerning a human living in the Neolithic. Some of the alleles discovered are the oldest examples of particular alleles among those identified in human remains so far. DNA evidence suggests the individual would have been lactose intolerant, and demonstrates a genetic relationship to representatives of first European

Neolithic cultures. Analysis of stable oxygen isotope ratios indicate patterns of either residential mobility or weaning age. Analyses of stable carbon and nitrogen isotope ratios allowed reconstruction of the individual’s diet, from which particular attention is drawn to the fact that the individual’s carbohydrate diet consisted of millet. This is the earliest isotopic evidence of millet’s presence in human diet in the Central Europe.

These discoveries provide exciting new information about human biological and cultural adaptations in world prehistory, and more specifically, are critically important in characterizing Kowal as a unique point in the discussion on the time and functioning of Neolithic sepulchral-ritual centers in Europe.

The Molecular part of the work was supported by the Ministry of Science and High Education project No N N109 286737.

References

- Behrensmeyer 1978: A. K. Behrensmeyer, Taphonomic and ecologic information from bone weathering, *Paleobiology* 4/2, 1978, 150–162.
- Beier 1988: H. -J. Beier, *Die Kugelamphoren-Kultur im Mittelbe-Saale-Gebiet und in der Altmark* (Berlin 1988).
- 1991: –, *Die megalithischen, submegalithischen und pseudomegalithischen Bauten sowie die Menhire zwischen Ostsee und Thüringer Wald* (Wilkau-Haßlau 1991).
- Burger *et al.* 2007: J. Burger/M. Kirchner/B. Bramanti/W. Haak/M. G. Thomas, Absence of the lactase-persistence-associated allele in early Neolithic Europeans. *Proc. Nat. Acad. Scien.* 104, 2007, 3736–3741.
- Choy *et al.* 2010: K. Choy/O. Jeon/B. T. Fuller/M. P. Richards, Isotopic Evidence of Dietary Variations and Weaning Practices in the Gaya Cemetery at Yeanri, Gimhae, South Korea. *American Journal Phys. Anthr.* 142, 2010, 74–84.
- Cook *et al.* 2001: G. T. Cook/C. Bonsall/R. E. M. Hedges/K. McSweeney/V. Boronean/P. B. Pettitt, A freshwater diet-derived C-14 reservoir effect at the Stone Age sites in the Iron Gates gorge. *Radiocarbon* 43/2A, 2001, 453–460.
- Czebreszuk/Szmyt 2011: J. Czebreszuk/M. Szmyt, Kurhan, rów i palisada w tradycji kultury ceramiki sznurowej. Próba rekonstrukcji „scenariuszy rytualnych”. In: H. Kowalewska-Matraszek/P. Włodarczak (eds), *Kurhany i obrządek pogrzebowy w IV–II tysiącleciu p.n.e.* (Kraków, Warszawa 2011) 123–130.
- /– 2012: –/–, Monumental Funeral Sites: Creation, Long-term Use and Re-use in the Neolithic and Bronze Age, Case studies from the Polish Lowland. In: M. Furholt/M. Hinz/D. Mischka (eds), „As time goes by?”, *Monumentality, Landscapes and the Temporal Perspective, Proceedings of the International Workshop „Socio-Environmental Dynamics over the Last 12000 Years: The Creation of the Landscapes II (14th–18th March 2011)”* 2 (Kiel 2012) 169–194.
- 27 Papathanasiou 2003; Lösche *et al.* 2006.
- 28 Katzenberg/Weber 1999.
- 29 Koško 1989; Wierzbicki 2006; Szmyt 2011; Czebreszuk/Szmyt 2011; 2012.

- Denaire 2009: A. Denaire, Radiocarbon Dating of the western European Neolithic: comparison of the dates on bones and dates on charcoals. *Radiocarbon* 51/2, 2009, 657–674.
- Drucker/Bocherens 2004: D. Drucker/H. Bocherens: Carbon and nitrogen isotopes as tracers of change in diet breadth during Middle and Upper Paleolithic in Europe. *Internat. Journal Osteoarch.* 14, 2004, 162–177.
- Dürrewächter *et al.* 2006: C. Dürrewächter/O. E. Craig/M. J. Collins/J. Burger/K. W. Alt, Beyond the grave: variability in Neolithic diets in Southern Germany? *Journal Arch. Scien.* 33, 2006, 39–48.
- Gerbault *et al.* 2011: P. Gerbault/A. Liebert/Y. Itan/A. Powell/M. Currat M. *et al.*, Evolution of lactase persistence: an example of human niche construction. *Phil. Transact. Royal Soc. London, Ser. B, Biol. Scie.* 366, 2011, 863–877.
- Haak *et al.* 2010: W. Haak/O. Balanovsky/J. J. Sanchez/S. Koshel/V. Zaporozhchenko V. *et al.*, Ancient DNA from European early Neolithic farmers reveals their near eastern affinities. *Publ. Library Scien. Ser. Biol.* 8, 2010, e1000536.
- IUSS Working Group WRB 2007: World Reference Base for Soil Resources 2006, first update 2007. *World Soil Resources Reports No. 103*. FAO (Rome 2007).
- Katzenberg/Weber 1999: A. M. Katzenberg/A. Weber, Stable isotope ecology and paleodiet in the Lake Baikal region of Siberia. *Journal Arch. Scien.* 26, 1999, 651–659.
- Koško 1989: A. Koško, Formy eksploatacji terenu stanowiska w epokach neolitu i brązu, In: A. Cofta-Broniewska (ed.), *Miejsce pradziejowych i średniowiecznych praktyk kultowych w Kruży Zamkowej, województwo bydgoskie, stanowisko 13* (Bydgoszcz, Poznań 1989) 13–61.
- Kozłowski *et al.* 2014: T. Kozłowski/B. Stepańczyk/L. J. Reitsema/G. Osipowicz/K. Szostek/T. Płoszaj/K. Jędrzychowska-Dańska/J. Pawlyta/C. Paluszkiwicz/H. W. Witas, Osteological, chemical and genetic analyses of the human skeleton from a Neolithic site representing the Globular Amphora Culture (Kowal, Kuyavia region, Poland). *Anthr. – Internat. Journal Scien. of Man* 52/1, 2014, 91–111.
- Krzak 1994: Z. Krzak, *Megalithy Europy* (Warszawa 1994).
- Lösch/Grupe/Peters 2006: S. Lösch/G. Grupe/J. Peters, Stable isotopes and dietary adaptations in humans and animals at Pre-Pottery Neolithic Nevalı Çori, Southeast Anatolia. *American Journal Phys. Anthr.* 131, 2006, 181–193.
- Makowiecki *et al.* 2014: D. Makowiecki/M. Makowiecka/G. Osipowicz, Animals deposits. In: G. Osipowicz (ed.), *Kowal 14 – Sepulchral and Ritual Place of people representing the Globular Amphora Culture* (Toruń 2014), 208–232.
- Nosek 1967: S. Nosek, *Kultura amfor kulistych w Polsce* (Wrocław 1967).
- Papathanasiou 2003: A. Papathanasiou, Stable isotope analysis in Neolithic Greece and possible implications on human health. *Internat. Journal Osteoarch.* 13, 2003, 314–324.
- Petchey *et al.* 2011: F. Petchey/M. Spriggs/F. Leach/M. Seed/C. Sand/M. Pietruszewski/K. Anderson, Testing the human factor: Radiocarbon dating the first peoples of the South Pacific. *Journal Arch. Scien.* 38/1, 2011, 29–44.
- Pleslová-Stiková 1981: E. Pleslová-Stiková, Chronologie und Siedlungsformen der Rinvác-Kultur und Kugelamphoren-Kultur Böhmens. *Jahresschr. Mitteldt. Vorgesch.* 63, 1981, 159–171.
- Ramsey 2008: C. B. Ramsey, Radiocarbon dating: revolutions in understanding. *Archaeometry* 50/2, 2008, 249–275.
- Reitsema/Crews/Polcyn 2010: L. J. Reitsema/D. E. Crews/M. Polcyn, Preliminary evidence for medieval Polish diet from carbon and nitrogen stable isotopes. *Journal Arch. Scien.* 37/7, 2010, 1413–1423.
- Reitsema 2012: L. J. Reitsema, *Stable Isotope Evidence for Human Diet Change in Poland*. (Ph.D., Ohio State Univ., Columbus 2012).
- Rumiński/Osipowicz 2014: J. K. Rumiński/G. Osipowicz, Neolithic adhesive from a T-shaped ornamental element excavated at site 14 at Kowal, Kuyavia, Central Poland. *Archaeometry* 56/1, 2014, 129–144.
- Schoeninger 1989: M. J. Schoeninger, Reconstructing prehistoric human diet. In: T. D. Price (ed.), *The Chemistry of Prehistoric Human Bone* (Cambridge 1989) 38–67.
- Sulimirski 1968: T. Sulimirski, *Cord Ware and Globular Amphorae North-East of the Carpathians* (Bristol 1968).
- Szmyt 1996: M. Szmyt, *Spółeczności kultury amfor kulistych na Kujawach* (Poznań 1996).
- 1999: –, *Between West and East, People of the Globular Amphora Culture In Eastern Europe: 2950–2350 BC*. *Baltic-Pontic Stud.* 8 (Poznań 1999).
- 2006: –, *Dead Animals and Living Society*, [w:] *www.jungsteinSITE.de*, December 15th, 2006, 1–10.
- 2011: –, *Kurchany w kulturze amfor kulistych. Dwa przykłady z Kujaw*. In: H. Kowalewska-Matraszek/P. Włodarczyk (eds), *Kurchany i obrządek pogrzebowy w IV–II tysiącleciu p.n.e.* (Kraków, Warszawa 2011) 109–121.
- Walker *et al.* 2009: P. L. Walker/R. R. Bathurst/R. Richman/T. Gjerdrum/V. A. Andrushko, The Causes of Porotic Hyperostosis and Cribra Orbitalia: A Reappraisal of the Iron-Deficiency-Anemia Hypothesis. *American Journal Phys. Anthr.* 139, 2009, 109–125.
- West *et al.* 2010: J. B. West/G. J. Bowen/T. E. Dawson/K. P. Tu, *Isoscapes. Understanding movement, pattern, and process on Earth through isotope mapping*, (London, New York 2010).
- White/Longstaffe/Law 2004: C. White/F. J. Longstaffe/K. R. Law, Exploring the effects of environment, physiology and diet on oxygen isotope ratios in ancient Nubian bones and teeth. *Journal Arch. Scien.* 31, 2004, 233–250.
- Wierzbicki 2006: J. Wierzbicki, *Megalithy kultury pucharów lejkwatych – czy tylko grobowce?* In: J. Libera/K. Tunia (eds), *Idea megalityczna w obrządku pogrzebowym kultury pucharów lejkwatych* (Kraków 2006) 87–101.
- Wiślański 1966: T. Wiślański, *Kultura amfor kulistych w Polsce północno-zachodniej* (Wrocław 1966).
- , 1969: –, *Podstawy gospodarcze plemion neolitycznych w Polsce północno-zachodniej* (Wrocław 1966).
- 1979: –, *Dalszy rozwój ludów neolitycznych, Plemiona kultury amfor kulistych*, In: W. Hensel/T. Wiślański (eds), *Prahistoria ziem polskich 2, Neolit* (Wrocław 1979) 261–299.
- Woźny 2005: J. Woźny, *Czerwona ochra i ziarna zbóż. Symbolika odrodzenia zmarłych w obrzędach pogrzebowych kultur archaicznych między morza bałtyckiego-pontyjskiego* (Bydgoszcz 2005).
- Wright/Schwarz 1999: L. E. Wright/H. P. Schwarz, Correspondence between stable carbon, oxygen and nitrogen isotopes in human tooth enamel and dentine: infant diets at Kaminaljuyú. *Journal Arch. Scien.* 26, 1999, 1159–1170.