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Early Medieval Clay Vessels from Podebłocie in the Light of Metrological Research

Abstract

Pottery constitutes the dominant category within the ceramic assemblage from the early medieval settlement complex at Podebłocie (Masovian Voivodeship). These vessels were multifunctional, typologically diverse, and used across different cultural contexts, exhibiting considerable variation in size and capacity. This paper presents the results of a preliminary study focusing on the capacity of selected clay vessels from Podebłocie. The state of preservation of eleven vessels allowed their volumetric capacity to be measured directly.

The results reveal non-random patterns that appear to be of broader cultural significance. Notably, the capacity of the largest vessel corresponds closely to one-sixth of a cubic cubit known from Byzantine metrological systems. This observation raises the question of whether the vessel, whose capacity approximates that of the *palatios modios*, may have functioned as a standard measure rather than merely a utilitarian container. Furthermore, within the analysed assemblage, there is a vessel whose capacity is exactly ten times smaller than that of the largest example; significantly, both vessels share identical proportions. In addition, a separate pair of vessels is characterised not only by identical constructional proportions but also by the same volumetric capacity.

These observations suggest that vessel capacity at Podebłocie was not determined solely by absolute dimensions, but could be predictably controlled through proportional relationships. Archaeological metrology applied to ceramic vessels thus provides insight not only into the possible influence of political, economic, and cultural contacts on pottery production, but also into deliberate technological choices and expressions of human ingenuity in early medieval craft practices.

Keywords: Podebłocie, early Middle Ages, metrology, clay vessels, capacity of pots

Ingrates seulement en apparence, les études métrologiques,
aux mains d'un chercheur intelligent, se muent en instruments
de sondage capables de déceler quelques
grands courants de civilisation.[1]
M. Bloch

Podebłocie, Trojanów commune, Garwolin district, is located approximately 100 km south of Warsaw, on the right bank of the Vistula River, today within the Masovian Voivodeship (Fig. 1). An early medieval settlement complex is situated at this locality (Fig. 2).[2] Its central element was a stronghold surrounded by three open settlements and a cremation barrow cemetery (Fig. 3). Archaeological investigations at Podebłocie

[1] Seemingly ungrateful, metrological studies, in the hands of an intelligent researcher, are transformed into probing instruments capable of revealing major currents of civilisation (Bloch 1934, 280).

[2] On the basis of stratigraphy and absolute dating (radiocarbon and thermoluminescence), the period of activity of the settlement complex at Podebłocie was divided into two chronological phases: Phase I, spanning from the 7th/8th century to the beginning of the 10th century, and Phase II, lasting from the beginning of the 10th century until the turn of the 11th/12th century (Dulinicz, Moszczyński 2013; Łukaszewicz, Łukaszewicz 2025).

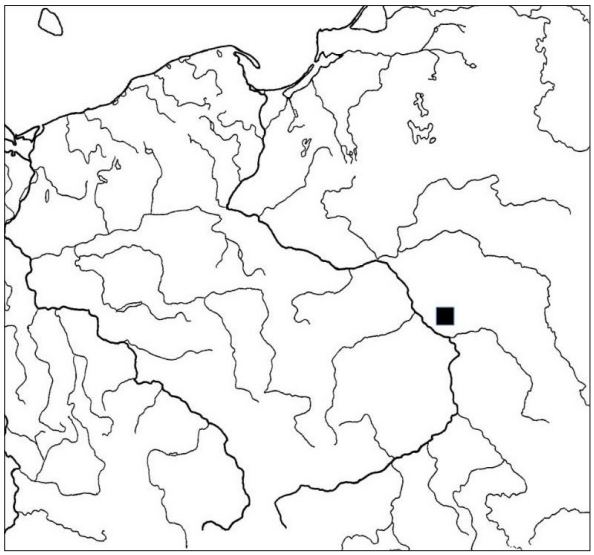

Fig. 1. Location of Podebłocie, Garwolin District, Masovian Voivodeship.

were conducted between 1981 and 1996. The excavations were directed, on behalf of the Institute of Archaeology of the University of Warsaw, by Professor Jerzy Gąssowski.

The most widely known discovery from Podebłocie consists of fragments of three clay objects which, due to their form and the inscriptions placed upon them, have been described as 'tablets'. These objects are unique on the scale of Polish archaeology and have been the subject of extensive discussion in scholarly literature.[3] Most researchers have concluded that the inscriptions visible on the 'tablets' are Greek texts of Christian content.[4]

In contrast, ceramic vessels represent the most numerous category of finds at the site. These are primarily fragments of clay pots, which constitute approximately 98% of the entire ceramic assemblage. It is generally assumed that these were multifunctional vessels, as indicated by the contexts in which they were discovered. The majority of vessels originate from domestic units – sunken-featured dwellings and semi-sunken residential structures – as well as from associated economic features. These were therefore vessels used in everyday life, serving primarily for the storage, preparation, and serving of food. In vessels discovered in storage rooms adjoining the inner rampart of the stronghold, cereals were stored. These may have been food supplies accumulated for the stronghold's garrison. Ceramic vessels were also discovered in the cremation cemetery, on one of the three barrows. These are most probably fragments of an urn that was placed on the barrow during the funerary ceremony of a young woman. In general outline, the vessels from Podebłocie do not differ from analogous finds from other early medieval archaeological sites in the territory of present-day Poland, either in terms of raw material, manufacturing technology, vessel form, decoration, or archaeological context.[5]

The principal objective of the present study is therefore to draw the reader's attention to another important aspect of research on early medieval ceramics, namely vessel capacity. I assume that clay vessels were also used as containers for various products, both liquid and dry. As in antiquity, they served not only for storage of food and other substances, but also for their transport and potential sale. This, in turn, necessitated the existence of vessels (containers) of specific capacity, which could simultaneously function as measures of goods. The question thus arises whether the archaeological material from Podebłocie includes vessels that could have fulfilled such a function. In seeking an answer to this question, I decided to take advantage of the possibilities offered in this respect by metrology. Metrology is one of the most important research tools that enables a broader and deeper understanding not only of the political, economic, and cultural contexts of archaeological sources, but also of humans themselves – their intelligence, knowledge, needs, and practical skills. Through metrological studies, we can learn why measures were once needed, what they were, and how they were used.[6] That such measures existed is beyond doubt. Proceeding from this assumption, I subjected to metric analysis a sample of vessels from Podebłocie whose state of preservation or method of reconstruction allowed for appropriate measurements to be taken.[7]

The research proceeded in three stages. First, the volume of selected vessels was measured. Next, on the basis of measurements of vessel height and diameter taken at strictly defined points (rim diameter, maximum body di-

[3] These finds are currently housed in the Museum of Polish History in Warsaw.

[4] Marczak 1998; Buko 2007; Łukaszewicz 2008; Łukaszewicz, Łukaszewicz 2025.

[5] Cf. Barford, Marczak 1992; 1994; Gardawski 1970; Hoczyk-Siwkowa 1979; Maj 1990; Dzieńkowski 2024.

[6] That vessel capacity was a matter of concern in antiquity is illustrated by the following joke from the Philogelos: "A Sidonian schoolmaster asked his pupil: how much does a five-kotyle lekythos hold? The pupil replied: wine or oil?" (cf. Thierfelder 1968).

[7] The present study is based on my doctoral dissertation, Ewa Marczak, "The Early Medieval extramural settlement at Podebłocie (site 3) in the context of the settlement complex", defended at the Faculty of History of the University of Warsaw in 2015, and constitutes the foundation for a publication currently in preparation on the search for metrical systems in the archaeological material from Podebłocie, taking into account other categories of artefacts.

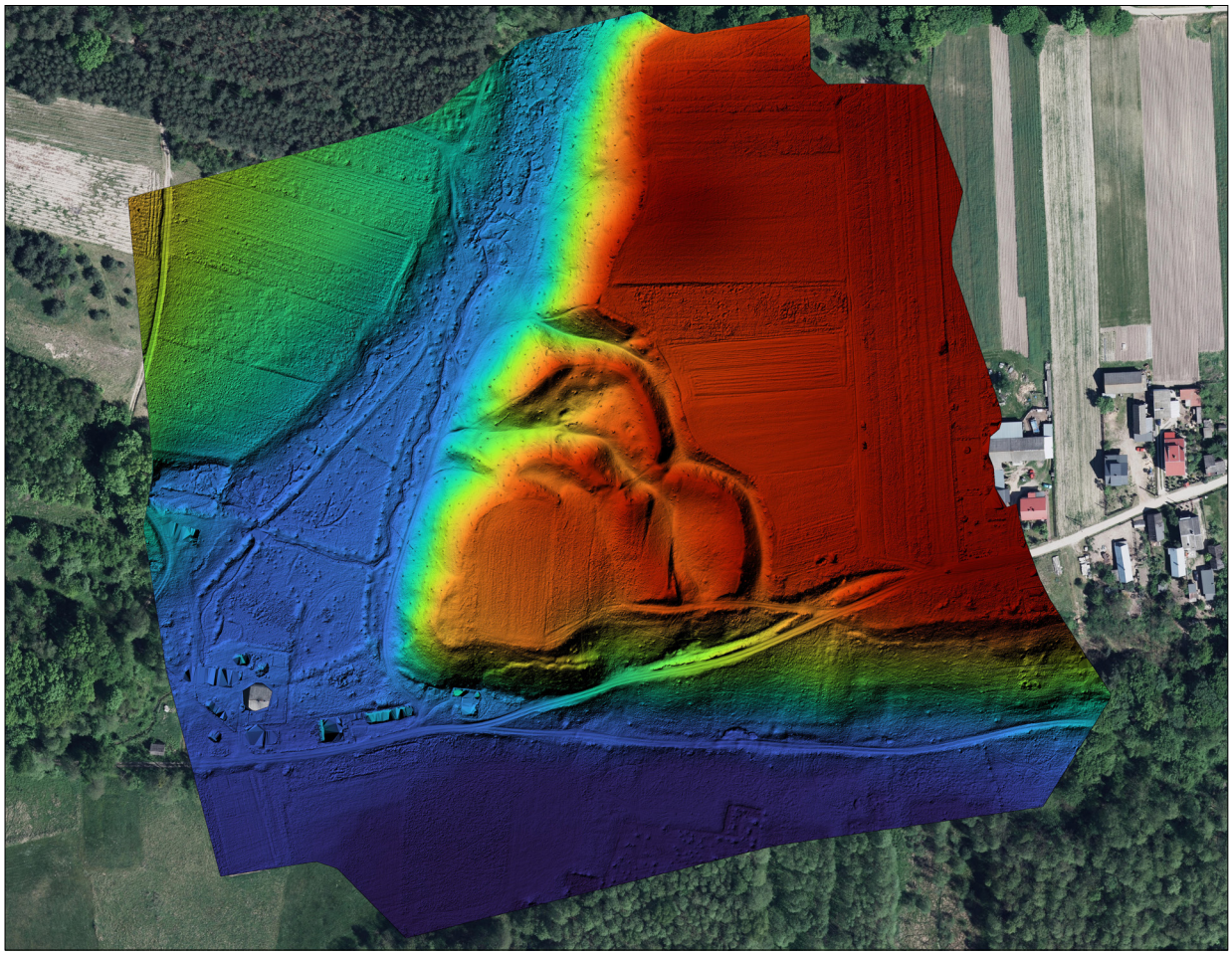

Fig. 2. LiDAR image of the Early Medieval settlement complex at Podebłocie (compiled by M. Bogacki).

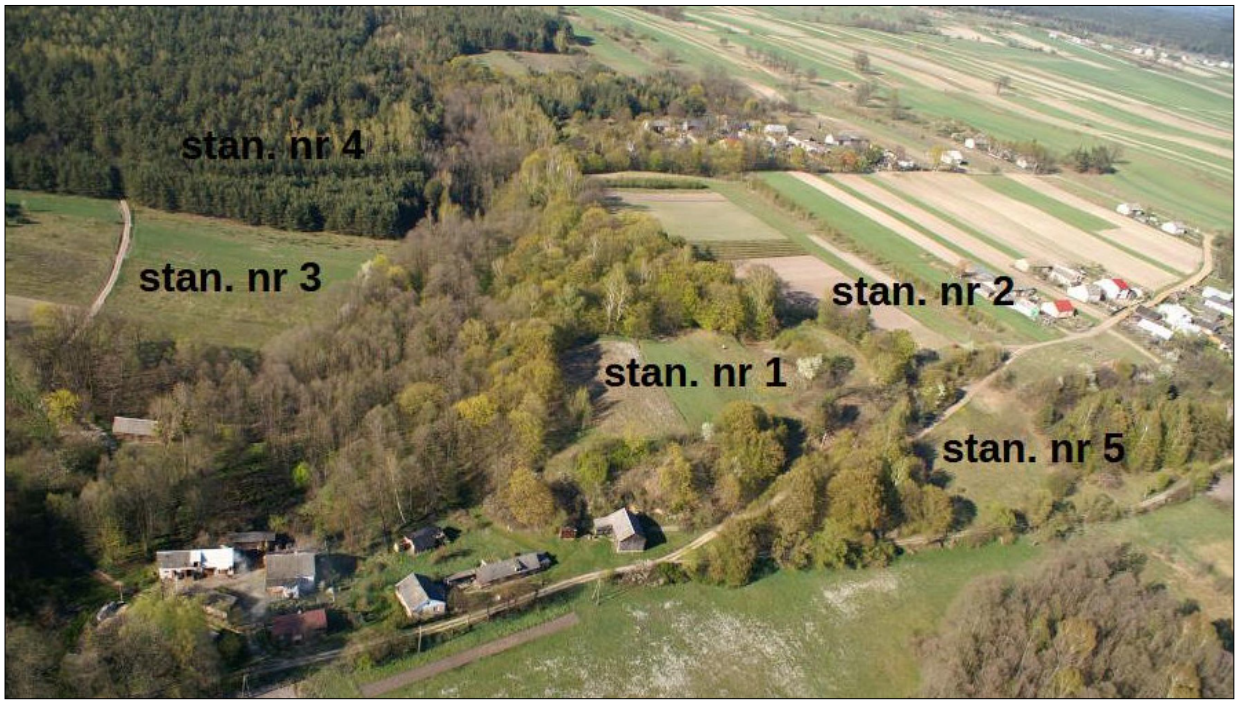

Fig. 3. Early Medieval settlement complex at Podebłocie: stronghold (site no. 1); open settlements: eastern settlement (site no. 2); western settlement (site no. 3); southern settlement (site no. 5); cremation barrow cemetery (site no. 4); (photo by K. Trel).

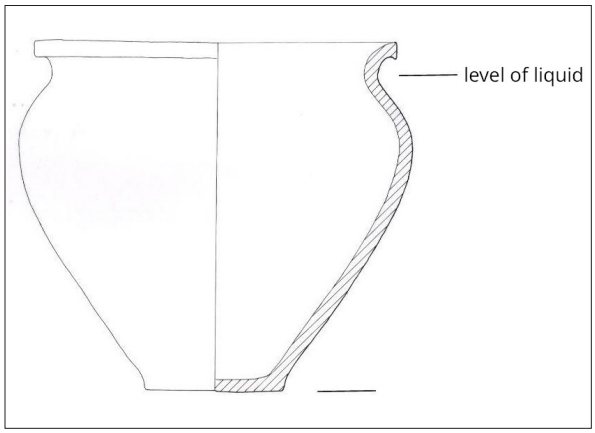

Fig. 4. Schematic representation of the analysed vessel, showing the level to which it was filled with liquid (drawing by E. Łukaszewicz).

ameter, base diameter), the proportions of the vessels were established. The final stage involved assessing the degree of dependence between vessel capacity and vessel form (proportions), and thus determining whether it was possible to produce vessels of a specific capacity by applying practical geometrical knowledge within the craft of pottery.

For the measurement of capacity, I selected eleven fully reconstructed vessels (G1–G11), whose state of preservation and method of reconstruction made it possible to determine their volume. Capacity was measured by pouring water into the vessel using a measuring cup of 0.25 litres. Due to the state of preservation of the vessels, which are mostly reconstructed from fragments, the interior surfaces of the vessels were secured with closely fitting plastic film. Water was poured up to the level at which the neck of the vessel transitions into the rim. Filling the vessel 'to the brim', that is above the adopted level, results in the liquid easily spilling during movement or transport of the filled vessel due to the form of the rim. This is particularly significant in the case of large vessels, which become heavy once filled (Fig. 4).

Among the analysed vessels, the smallest vessels (G1–G3) have a capacity of 0.75 litres. The largest vessel proved to be vessel G11, with a capacity of 17.5 litres. It is noteworthy that within the examined sample there is a vessel exactly ten times smaller than vessel G11 – namely vessel G5 with a capacity of 1.75 litres. Thus, there are three vessels with a capacity of 0.75 litres (G1–G3); one vessel each with capacities of 1.50 litres (G4), 1.75 litres (G5), 2.00 litres (G6), and 2.75 litres (G7); two vessels with a capacity of 4 litres (G8 and G9); one vessel with a capacity of 7 litres (G10); and one vessel with a capacity of 17.5 litres (G11) (Tab.1).

The next stage of the metric analysis involved determining vessel form and size on the basis of dimensions

Table 1. Capacities of vessels nos. G1–G11 (in litres), expressed also as multiples of the basic unit of measurement (BUM = 0.25 l).

number	volume	bum (×)
G1	0,75 l	3
G2	0,75 l	3
G3	0,75 l	3
G4	1,50 l	6
G5	1,75 l	7
G6	2,00 l	8
G7	2,75 l	11
G8	4,00 l	16
G9	4,00 l	16
G10	7,00 l	28
G11	17,5 l	70

such as height (h), rim diameter (Ø rim), body diameter at the point of maximum expansion (Ø body), base diameter (Ø base), as well as proportions – the ratio of vessel height to rim diameter (h/Ø rim), height to body diameter (h/Ø body), height to base diameter (h/Ø base), and the ratio of rim diameter to body diameter (Ø rim/Ø body).

From the eleven vessels included in the initial sample, five vessels (G5, G7, G8, G9, and G11) were selected for the second stage of research. These vessels are well preserved and correctly reconstructed (Fig. 5). They originate from the stronghold (G5) and from the same adjacent settlement (G7, G8, G9, G11), from features assigned to the first chronological phase of the analysed settlement complex. They are also characterised by a high degree of similarity in terms of raw material and manufacturing technology (Tab. 2).

The results of the metric analysis of the form of the five vessels (G5, G7, G8, G9, G11), based on dimensions and proportions, are presented in Tab. 3. The greatest similarity is observed between vessels G8 and G9. They are characterised by the same height, the same base diameter, the same value of the height-to-base-diameter ratio, and a very similar value of the rim-to-body-diameter ratio. The second pair of vessels whose metric values indicate a high degree of similarity consists of vessels G5 and G11. Although they differ in size (vessel G5 is ten times smaller than vessel G11), they share the same values of the height-to-rim-diameter ratio, the height-to-body-diameter ratio, and the rim-to-body-diameter ratio – that is, very similar proportions. Vessel G7 exhibits proportions similar to these, particularly in that its height-to-rim-di-

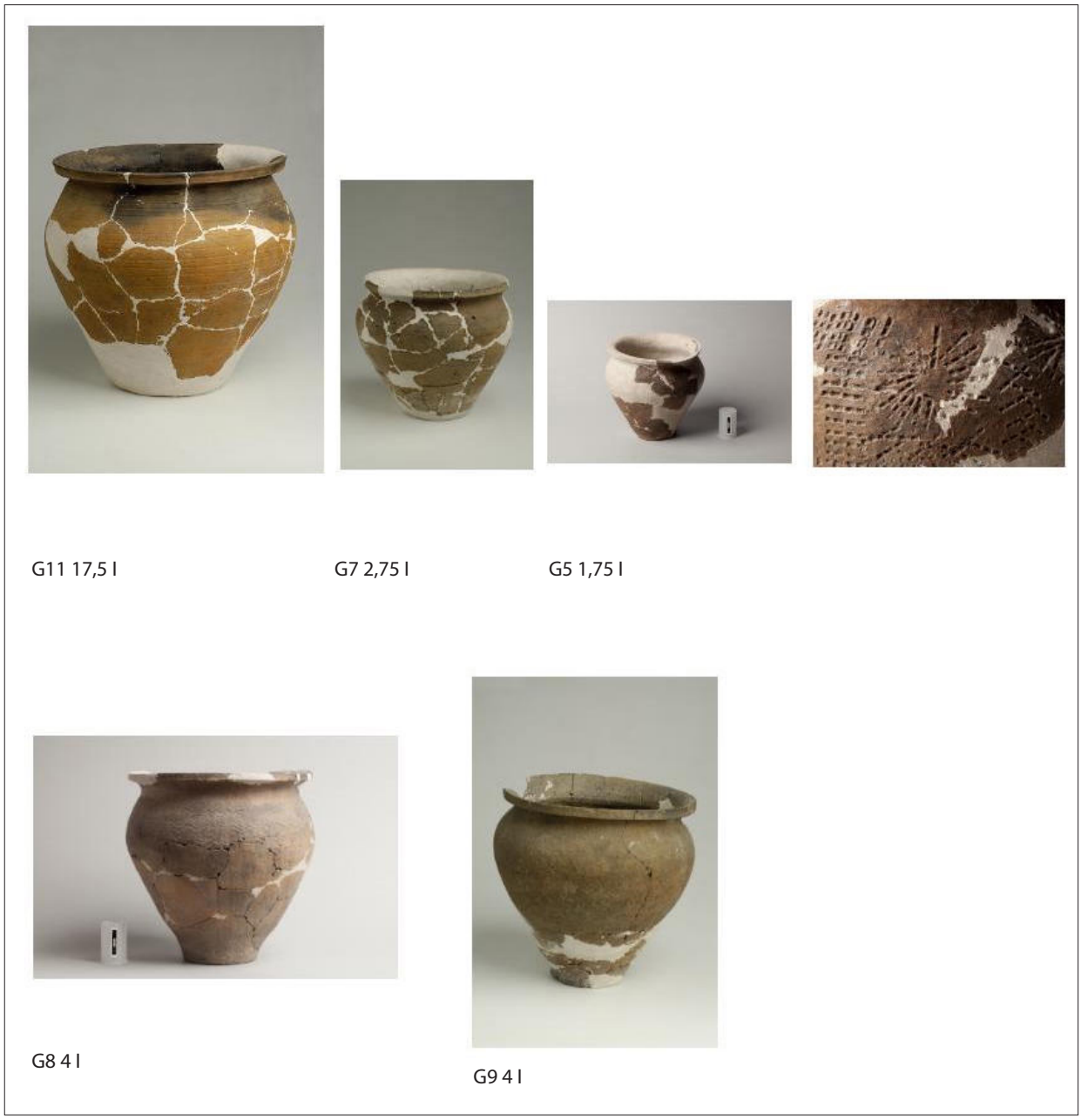

Fig. 5. Clay vessels: G5 (site no. 1), G7-G10 (site no. 3); (photo by M. Bogacki).

ameter ratio is identical to that of vessels G5 and G11 (Fig. 6).

On the basis of the data presented in Tab. 3, it follows that vessels with very similar dimensions and proportions have identical capacity, for example, vessels G8 and G9. Vessels of different size but identical construction proportions represent exact (i.e. expressed as whole numbers) multiples of capacity, as exemplified by vessels G5 and G11. Achieving a specific multiple of a vessel's volume depends primarily on its height and rim diameter. In the case of vessels G5 and G11, the difference in height amounts to 155 mm, while the difference in rim diameter is 150 mm. Thus, in order to obtain a vessel ten times larger than vessel G5, it was sufficient to increase the height and rim diameter by approximately 150 mm, while maintaining identical proportions: the ratio of vessel height to rim diameter and height to body diameter. Measurement could have been accomplished using

Table 2. Source data for vessels G5, G7, G8, G9, and G11 derived from field documentation from 1982, 1984, 1986, and 1988.

No.	Location	Context	Chronology	Remarks	Field inventory no.
G5	Hillfort – site no. 1, trench II	feature no. 1	Phase I	Ferruginous clay; tempering admixture; traces of wheel-finishing; oxidising firing; solar ornament executed with a potter's comb; fragments from the same vessel (?) were also found in the adjacent settlement – site no. 3, in feature no. 10 dated to Phase I	Pb1/82/II/ /17 w.
G7	Adjacent settlement – site no. 3, trench VIII	cultural layer no. V, outside features	Phase I	Ferruginous clay; tempering admixture; traces of wheel-finishing; oxidising firing; incised ornament – straight lines; a perforation made in the upper part of the vessel body	Pb/3/86/ VIII/V/46–47
G8	Adjacent settlement – site no. 3, trench I (test trench)	feature no. 1 – residential and economic sunken-featured building, at the furnace outlet	Phase I	Ferruginous clay; tempering admixture; traces of wheel-finishing; oxidising firing; incised ornament – wavy lines executed with a potter's comb	Pb/3/84/I/ /82 w.
G9	Adjacent settlement – site no. 3, trench XVIII	feature no. 20 – residential and economic sunken-featured building, at the furnace outlet	Phase I	Ferruginous clay; tempering admixture; traces of wheel-finishing; oxidising firing; undecorated	Pb/3/88/ XVIII/20/ XIV/41
G11	Adjacent settlement – site no. 3, trench VII	feature no. 4 – residential and economic sunken-featured building, at the furnace outlet	Phase I	Ferruginous clay; tempering admixture; traces of wheel-finishing; oxidising firing; incised ornament – straight lines	Pb/3/86/ VII/4/II

Table 3. Measurements (in millimetres) of selected vessels (nos. G5, G7, G8, G9, and G11). The bases are not preserved in vessels G7 and G11.

Vessel no.	G5	G7	G11	G8	G9
Height (h)	165	190	320	230	230
Rim diameter (Ø rim)	170	195	330	215	235
Maximum body diameter (Ø body)	180	190	350	200	240
Base diameter (Ø base)	80	–	–	90	90
h / Ø rim ratio	0.97	0.97	0.97	1.06	0.97
h / Ø body ratio	0.91	1.00	0.91	1.10	0.95
h / Ø base ratio	2.06	–	–	2.50	2.50
Ø rim / Ø body ratio	0.94	1.02	0.94	1.00	0.97
Volume (litres)	1.75	2.75	17.5	4.00	4.00

a cord, a stick, or a metal rod of a specific length, or even by using one's own hand.[8] I believe that potters producing vessels of a specific size (e.g. containers and measures, that is, vessels used for measuring) possessed knowledge in this respect that derived not only from their own professional experience, but also from tradition and from a canon that may have governed pottery production in a given region and that was itself a derivative of a specific metrological system.

Summary

According to the rules of statistical methodology, the sample of vessels from Podebłocie described here may appear insufficiently representative due to its size. Nevertheless, its metric analysis has provided interesting data which, when combined with the multifaceted cultural context provided by the archaeological material, encourages further work on the application of metrology in the analysis of archaeological finds.

An example is vessel G11, the largest vessel in the analysed assemblage, with a capacity of 17.5 litres. This vessel was discovered in the western settlement (site no. 3), in a semi-sunken residential-economic structure built on a square plan. The vessel was located near a horseshoe-shaped hearth with a domed superstructure, constructed of stone and clay. The dwelling from which the vessel originates was assigned to the first chronological phase of the settlement, dated from the turn of the 7th/8th century to the beginning of the 10th century. In this context, it is worth noting that in Byzantine territory a capacity measure known as the *pechys*, or cubit – in this case a cubic cubit – was in use. Its value amounted to approximately 102.5 litres. One sixth of a cubic cubit constituted the *palatios modios*, with a volume of approximately 17.08–18 litres.[9] This raises the question of whether the vessel from Podebłocie, with a capacity corresponding to that of the *palatios modios*, functioned as a measure. There is much to suggest that this was indeed the case.

Within the analysed assemblage, there is also a vessel with a capacity exactly ten times smaller, namely 1.75 litres (G5). This fact may indicate that this vessel also functioned as a measure. On the surface of this smaller vessel there is an exceptionally interesting ornament – or rather a graphic narrative – in the form of solar and possibly zoomorphic symbolism, executed with a potter's comb, with figural representations placed within square fields (metopes). This vessel, functioning as a measure, may have served a cultic role.[10] It is a find unique on a European scale. The only analogy known to me is a vessel discovered in a Slavic-Avar skeletal grave in present-day Slovenia.[11]

Attention should also be drawn to vessels G8 and G9, which display very similar forms and have identical capacities of 4 litres. These vessels originate from the western settlement, also from its first phase of use. In both cases, they were found in dwellings, in semi-sunken structures, near the hearth outlet (Table 2). Analogies for these vessels occur mainly at early medieval sites in southern Poland, for example at Chodlik.[12]

It is also necessary to mention one additional vessel from the stronghold at Podebłocie, which, due to its state of preservation, was not included in the present study. This is a clay vessel of a form rarely encountered in early medieval material, resembling a modern flowerpot (so-called vessel-shaped vessel), as well as a measure (*modios*) known from the Mediterranean world.[13]

Conclusion

The presented results of the metric analysis of clay vessels from Podebłocie, together with previously published metrical studies of *płacidła* from this site,[14] may indicate certain cultural connections between the middle Vistula region and Byzantine influences during the first settlement phase of the analysed settlement complex.[15] The presented source base is very modest and does not indicate direct political, economic, or cultural relations with the Byzantine Empire. It does, however, allow us to perceive intercultural transmission of patterns mediated by neighbouring peoples or politico-economic structures. Through metrology, it has been possible to "discover" the presence of certain elements of Byzantine culture – namely measures – in the clay vessels from Podebłocie. In this case, the issue is not the origin of the vessels, as all of them are local products, but rather the idea according to which they were made. Metrology thus served as a tool for uncovering this idea and for drawing attention to the fact that an ordinary clay vessel found in an area

[8] The former anthropometric unit of length known as the span (the distance between the tip of the thumb and the tip of the little finger of an outstretched hand) measures approximately 15 cm.

[9] Similarly to the metretes used in Greco-Roman Egypt, sometimes referred to as the keramion (Łukaszewicz 2001, 340).

[10] This issue requires a more extensive discussion of both the graphic representation on vessel G5 and the archaeological context of this find, which would go beyond the main scope of the present publication.

[11] Ruttkay 1976, 245–395.

[12] Dzieńkowski 2024, 413–432.

[13] Barford, Marczak 1992.

lying outside the sphere of the great civilisations may be local only in a physical sense.

The mention of the solar ornament on vessel G5 and its analogy from a Slavic-Avar grave in Slovenia is also significant. The find from Podebłocie is associated with the first settlement phase at the site. During this period, the Avars played a significant political and economic role in Europe and, as a nomadic and warrior people, were effective intermediaries of intercultural exchange.[16]

The results of the metric analyses of the Podebłocie vessels may also, to some extent, contribute to explaining the presence of the so-called "tablets" in the middle Vistula region and indicate directions for further research in this area.

Metrology is not only a means of identifying the presence of "great currents of civilisation", political structures, and economic systems on the basis of specific metric arrangements, but also a reflection of everyday life, in which counting, measuring, and weighing are inseparable from human activity.

For a long time, the importance of metrology in historical research has been emphasised.[17] Its significance has been such that it led to the emergence of an independent scholarly discipline – historical metrology – primarily concerned with economic history based on written sources. Perhaps metrology should also be applied more extensively in archaeological research, leading to the development of archaeological metrology as a specialised tool for understanding the past on the basis of archaeological sources. Indeed, many publications give the impression that metrological studies occupy a marginal position in archaeology. This is particularly evident in publications concerning ceramic vessels. Although there are works that stress the necessity of calculating and reporting vessel capacity[18] – provided that the state of preservation allows for this – in most published ceramic studies this fundamental piece of information, namely vessel capacity, is absent.

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[14] Marczak 2013.

[15] Cf. Schilbach 1970; Wipszycka-Bravo 2001; Laiou 2002; Nikodem, Sikorski 2021.

[16] Pohl 2018.

[17] Kula 1959; 1970.

[18] Buko 1990, 305–315; Rice 2015, 218, 240–241,420.

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