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Unveiling the Use of Wide Horizontal Rim Vessels (Bronze Age Northwest Iberian Peninsula)

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Abstract: This paper addresses a "wide horizontal rim vessel" belonging to the collection of Fundação Sousa d'Oliveira (Azores). Although its provenance and the circumstances of its discovery are currently unknown, the authors contend that this vessel should be attributed to the Iberian Northwest and, more specifically, to the Portuguese territory, in line with the highly homogenous distribution of this type of pottery. A morphological and stylistic study has been carried out establishing its singularity with regards to the decorative composition of the rim, which is without parallel amongst dozens of vessels of the same "family". During the study of this piece, it has been possible to observe traces of soot and organic residues deposited both on its interior and exterior surfaces, which is recurrent in these vessels. The nature of these substances has never been determined in previous studies. In this article, we present and discuss the results obtained from the chromatographic analyses of the organic residue traces found on the vessel.

Keywords: wide horizontal rim vessels; organic residue analysis; Bronze Age; iberian northwest; chromatography; Sousa d'Oliveira Foundation

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1. Introduction

The study of pottery bibliographically established as "wide rim vessel", or "wide horizontal rim" (WHR) vessel (in Portuguese, "vasos de largo bordo horizontal" or "vasos LBH"), accounts for a notable number of works, published since the beginning of the 20th century [1]. This type of pottery is defined by peculiarities regarding the rim shape and decoration (albeit, not always present), which is why it was identified in early studies as "vases d'une forme spéciale (semblables à des chapeaux), avec des dessins sur les bords" (vases of a special shape (such as hats), with decoration on the edges) [2]. Following the earliest reports, there appeared soon after, a monographic text featuring all of the specimens known at that time, categorized by the author as "inverted hat-shaped vessels" [3].

In the following decades, sporadic findings continued, for the most part in the Minho (Portugal) and in Galicia (Spain), with all the existing information gathered and critically analyzed at the end of the last century in a reference text dedicated to the necropolis of Agra de Antas (Esposende) and its radiocarbon dating [4]. This work also comprehensively elaborates on the diverse contexts of the WHR vessels, funerary (including cists without tumulus, pits, monuments with tumulus) and non-funerary, as well as undetermined cases [4] (pp. 7–13), a question also considered by Bettencourt [5,6] (p. 624).

Throughout the 20th century, many different chronologies were attributed to these vases, based on stylistic, decorative and stratigraphic criteria (when known): among others (for a detailed view of the other proposals see Ref. [4] (pp. 13–16)), to the final stages of the Neolithic [2] (p. 66); to the final stages of the Iron Age, due to the findings in the Lusitanian-Roman layer of the settlement of Terroso (Póvoa de Varzim), but allowing for the possibility of a long diachronicity-"... the typical form lasted many centuries" [3] (p. 664); to

the Iron Age (2nd half of the 1st millennium BC), related to "pre-Roman Castro ceramics" but with a remote Chalcolithic tradition [7], a hypothesis followed by Cardozo [8] (p. 87); to the Chalcolithic, namely to its later phase of Bell Beaker scope [9] (p. 281), [10] (p. 17); to the Bronze Age, in particular, the vases from the necropolis of the municipality of Esposende were attributed to the later stages of the period [11] (p. 45).

It was only possible in the last two decades of the last century to specify the chronology of WHR pottery, when good radiocarbon dated contexts became available, forcing the withdrawal of some of the above-mentioned proposals and confining speculation to the Bronze Age, although at different stages. Firstly, the excavations carried out in the 1980s at the settlement of Bouça do Frade (Baião), where some ceramic fragments of this type were collected, made it possible to obtain three C14 dates that were coherent with each other and with the respective chrono-cultural contexts, indicating the 10th-8th centuries BC, therefore, the end of the Bronze Age [12] (p. 64). Later, the excavations at the settlement of Sola (Braga) also provided several ceramic fragments from WHR inserted in the same layer as structure no. 1, for which there are two dates that revealed a chronology between the 17th and 16th centuries B.C., or in other words, the 2nd quarter of the 2nd millennium BC [6] (pp. 624 and 629); [13].

At the same time, it was possible to date the bone remains of one of the graves in the necropolis of Agra de Antas (Esposende), a necropolis which, as a whole, had provided 13 WHR vessels in addition to another semi-cylindrical one [11,14]. The results pointed to the early stages of the Late Bronze Age, from the 14th to the 11th century BC [4] (p. 16). Subsequently, another date was published for the same grave which confirmed the chronology previously determined, and whose weighted average was between the beginning of the 14th century and the middle/end of the 12th century (1406-1132 BC) [5] (pp. 149–150).

In addition, within this century, new projects developed by Ana M.S. Bettencourt's team have brought forward important contributions, with new findings and good contexts, namely funerary and C14 dated, which were partly compiled by Sampaio in his study on the Bronze Age in the Ave river basin, specifically at Pego (Braga), Quinta do Amorim and Faísca [15,16].

In 2015 this pottery category was the focus of a systematized study covering, collectively and comprehensively, the finds from Portugal and Spain (incorporating a catalogue of 76 pieces), all circumscribed to the Northwest of the Iberian Peninsula [17]. Subsequently, and as a result of various circumstances, new findings have been published and three vessels from the Mamoa of Carreiro da Quinta (Vila Verde) [18] have been unveiled. More recently, one vessel from Bexo (Didro, A Coruña) [19] and two vessels from negative structures of Chã da Mourisca (Ponte de Lima) [20,21] have also been revealed. In 2021, another vessel belonging to the Sousa d'Oliveira Foundation (Ponta Delgada, Azores) was disclosed online, and it is this vessel that is the basis of this paper.

This WHR vessel, unfortunately of unknown provenance—unquestionably, a limiting factor—was entrusted to be studied to the Institute of Archaeology of the Faculty of Arts and Humanities of the University of Coimbra. A preliminary approach was planned for the end of 2021, aimed at its public communication in an academic setting [22]. Continuing this approach and trying to bypass some of the constraints of the vessel's unknown provenance and find context, this present study further develops issues only touched upon in the previous work, besides others, and presents the unpublished results of a newly performed chromatography analysis of the organic residues preserved on the surfaces of the vessel. It is important to relate that the vase was not on display, but kept in a private box, away from sunlight, frequent handling or organic contaminants.

This type of analysis, of extreme importance in widening the knowledge of the contents and usage of pottery containers, does not have an extensive prior history in Portuguese archaeology, with the exception of the work focused on Roman materials which one colleague (Oliveira, C.) has been developing. Within Prehistory and, in particular, the study of WHR vessels, this is a pioneering work. However, with very different problems and

objectives, previous chromatographic analysis on burial sediments from the Southwest Bronze Age should be noted [23]. More recently, one of the co-authors of this study (Oliveira, C.) successfully used gas-chromatography coupled with mass spectrometry to characterize the organic contents in ceramic vases recovered in a megalithic tomb from Alentejo [24].

Some archaeometric analysis had already been performed on WHR vessels, such as X-ray diffraction regarding the mineralogical characterization and the potential raw material source areas [25], and preliminary FTIR studies of the residues [26]. Nevertheless, our chromatographic study on WHR vessels is pioneering, even though the existence of organic residues in this pottery category is recognized and pointed out by many scholars [4–6,27], with Mário Cardozo having noted, even in the 1930s, that almost all the studied vessels were "internally and externally burnt with dark crust at the opposite side of the handle" [8].

With the present contribution, we aim to raise awareness in the scientific community of a new WHR vessel. Since it is impossible to comment on the find or deposition context of this vessel, our work is focused on the study of the formal and stylistic elements of this piece, to which was added the valuable contribution of the analysis results of the remaining organic residues, allowing for some clues about the nature of the content and its putative use.

Despite everything, the restraints arising from the described situation did not prevent us from proceeding with the study of this vessel and publication of the data obtained, which, in our opinion, is justified, making another specimen of WHR known.

2. The Institutional Context of the Vessel and Some Considerations Regarding Its Provenance

As previously mentioned, the provenance and archaeological context of the vessel are unknown, and, equally, the way it entered the collection of Manuel Sousa de Oliveira (1916–2001) has not yet been clarified. During the inventory work of the archaeological collection, the acronym "FSO A. 0016" was attributed to it. It was not possible to obtain additional information regarding its provenance, as the Foundation is still carrying out an inventory of the collection and the analysis of the documentation left by its benefactor [28,29].

However, because it is a pottery type which is unmistakable due to its expressive formal characteristics (WHR), with a very restricted and cohesive geographical distribution, confined to the Northwest of the Iberian Peninsula (the Minho and Galicia) (Figure 1), we can assume, with little doubt, that its provenience must be from within this area. We would add, concerning the morphological and stylistic characteristics of the vessel (vide infra), that these are particularly common in vessels from the North of Portugal when compared with the pieces from Galicia [17] (pp. 63–64, 67 and Figure 17 from the same reference).

Such an assumption is further supported by the circumstances of the professional life of Sousa de Oliveira, because between 1951 and 1963 (or 1964, depending on the consulted source), he held functions as director of the Museu Regional de Viana do Castelo, currently Museu das Artes Decorativas [28,30], during which time the vessel fell into his hands. Sousa de Oliveira held an interest in Archaeology and collaborated during that period in Abel Viana's excavations of hillforts of the Viana do Castelo region and neighboring areas, such as the hillfort of São Caetano (Monção). He presented at least five communications in Iberian congresses [31–35].

Of particular interest to the present study could be the communication he took to the conference in Madrid (1954) and which was included in the corresponding program of oral presentations with the title "Some considerations on the Bronze Age of Portugal" [36] (p. 41). In a report concerning the same conference, Afonso do Paço mentions Sousa de Oliveira's communication with a slightly different title: "Notes for the study of the Bronze Age in the North of Portugal" [37]. As is known, the WHR vessels are, generically, from the Bronze Age, despite the broad chronology attributed to them by some historiographical works (see Section 1), which is why we should not rule out the hypothesis of him having referenced the vessel presently being studied, if he already had it in his collection. Unfortunately, as far as we know, the communication was not published. Only a thorough search through

the Foundation's documental archives, once they are organized and made available, could bring more information to light regarding this communication, should its notes exist. Therefore, we cannot close the issue of the vessel's unknown provenance, even though it does not seem possible to bring anything else forward at this moment.

Figure 1. The distribution area of WHR vessels in the context of the Iberian Peninsula based on information from Nonat et al. [17] (image authored by José Luís Madeira).

It is important to note that, from 1951 to 1963, no information on the finding of WHR is known. Nevertheless, we should not ignore the WHR vessels found before 1951, whose whereabouts are unknown. Falling into this category are at least two of the three vessels from Monte da Ola, Vila Fria (Viana do Castelo), found before 1929, almost at ground level, of which only one was published (belonging to Joaquim Fernandes Ferreira, a teacher at the secondary school of Viana do Castelo, later joining the Museum of Viana do Castelo) [10,38,39]. The excavations later made in the area of this find did not reveal any empirical evidence of a funerary nature, although oral information has pointed to the existence of rectangular shaped graves, structured and covered with slabs each containing a vessel [39] (pp. 79–80). The only known date relates to "charcoals exhumated from the first layer of C9 square, Sector 1", which the authors legitimately admit corresponds to a level of occupation/abandonment related with the necropolis [39] In Ref. [5] (p. 149) the author refers to the work previously mentioned as " . . . necropolis of rectangular cysts of Monte Ola, Vila Fria, Viana do Castelo, where at least three cysts were detected, dating between 1251-938 BC". We have not found this information in the aforementioned work).

In Faísca (Guimarães, Portugal), multiple vessels appeared, at different times during the year 1935, associated with pits cut in sandy clay ("saibro"), from which only eight were recovered [8]. Both the casuistic and archaeologically uncontrolled ways in which

most of the findings occurred until the 1950s, as well as the information regarding those processes, systematized by Soeiro [11] and Cruz and Gonçalves [4], make the practice of artefact gifting and the uncertainty of some of their itineraries very clear.

3. The Vessel

It is a complete vessel, worn at the rim, where two small fissures can also be highlighted (Figure 2). The pot was manufactured with a medium quality compact paste with small (<0.5 mm) to medium (between 0.5 and 1 mm) well-distributed non-plastic inclusions of sandy characteristics, containing some micaceous elements. The surfaces were evenly smoothed and were predominantly of brownish color [40]. Since the vessel is complete, it is not possible to observe the color of the core and the sub-surface, which would help to determine with precision the type of firing.

Figure 2. Detail of external surface and its tonality.

It has a semiglobular body and convex base, both irregular (Figure 3), standing out with the characteristic shape of the rim, being wide and sub-horizontal (tilted slightly towards the interior), with 2.9 cm wide; the rim is rounded. The height of the vessel is 8 cm, and the external rim diameter is 16 cm. It has a ribbon handle placed between the intersection of the rim and the body, ending near the bottom.

There is no decoration on the body and the handle, in contrast to the rim, which is decorated with wide incisions of varying depth, where a glimpse of very subtle traces is also attested (Figure 4). Linear motifs were marked, parallel to each other and perpendicular to the rim, of variable dimensions, i.e., not always connecting its edges; partially, these motifs are intersected by other, discontinuously, that follow the rim's orientation. A somewhat irregular organization stands out, albeit of metope tendency and sometimes withholding spaces (or where almost imperceptible incisions are) which alternate, also in an apparently arbitrary way, with the composition of those motifs.

Figure 3. Multiple perspectives of the vessel.

The vessel under study finds parallels in some of the main tables of pottery types from the Bronze Age of the North of Portugal, corresponding to "Shape 3" of Bouça do Frade (Baião), from a Bronze Age level [12] (p. 23), and to "Shape 13" from the Sola (Braga) settlement, from levels of the second and third quarters of the 2nd millennium B.C. [13]. Overall, within this category of ceramics it matches the sub-group WHR1 [17] (p. 151).

One of the most interesting, while not especially surprising, aspects is the existence of soot traces and of organic remains in the exterior, interior, and rim of the vessel. On its external surface, in particular within the bottom area, there is a concentration of soot marks, clearly indicating that the vessel was exposed to fire during its usage. In contrast, on the internal surface at the rim area, in a very pronounced way over the rim, and especially in the opposite half to the handle, there are expressive darkened traces of burnt substances that, in some cases, form a kind of crust. Note that, on the rim, there are areas where the brownish surface color is lighter, suggesting they have been covered with the (now absent) substance (Figure 5).

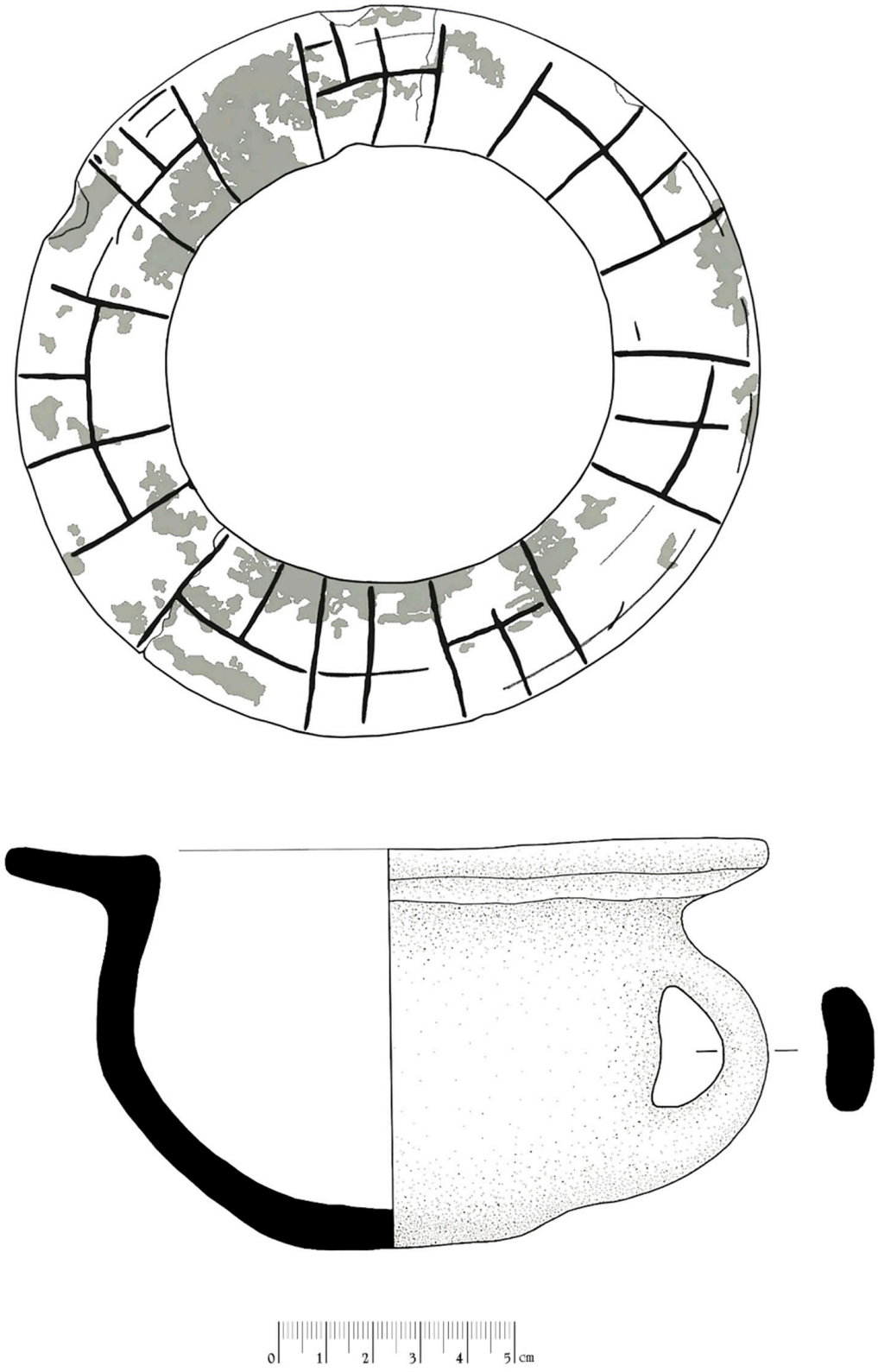

Figure 4. Decorated rim and shape of the WHR vessel.

Figure 5. Dispersion of the soot marks on the rim and detailed views of the decoration and burnt marks.

4. Organic Residue Analysis

In order to analyze the composition of the dark residues observed, powdered samples were taken and analyzed by gas chromatography-mass spectrometry (GC-MS). The sampling was performed at the inner wall of the vessel, in a non-exposed area, and the sherd surface was removed by abrasion and excluded from chromatographic analysis. The chromatograms were screened for the presence of common organic contaminants, such as squalene (a contaminant from skin fats that suggests the manipulation of the ceramic material without gloves), plasticizers (from plastic bags), personal cosmetic products (again from the manipulation of the ceramic material without gloves), as well as traces of glues and consolidants used in the conservation of ceramics. None of those compounds was detected.

4.1. Extraction of Organic Compounds

Approximately 1 g of potsherd was collected with a clean scalpel, and grounded to a fine powder with an agate mortar and pestle. 7 mL of a mixture of chloroform: methanol (2:1 v/v) was added to the sample. The mix was vortexed, extracted in a sonic bath for 20 min and centrifuged at 2500 rpm for 15 min. The supernatant (solvent) was transferred with a Pasteur pipette and the extraction procedure was repeated. Both supernatants were combined and dried at 40 °C using a gentle stream of nitrogen. The resulting dried extract was re-suspended with n-hexane and derivatized with N,O-bis (trimethylsilyl) trifluoroacetamide with 1% of trimethylchlorosilane (BSTFA + 1% TMCS) in a microwave oven (700 W, 30 s). After removing the derivatizing agent in excess under a gentle stream of nitrogen, the extract was redissolved in n-hexane and analyzed by GC/MS.

4.2. Gas Chromatography–Mass Spectrometry

The chromatographic analyses were performed with a Shimadzu GC2010 gas chromatographer coupled to a GCMS-QP2010 Plus Mass Spectrometer device. The equipment was operated in full scan mode, with the following experimental conditions:

(a) column Zebron ZB-5HT (15 m length, 0.25 mm I.D., 0.10 µm film thickness) using helium as carrier gas with a constant flux of 1.5 mL min^{-1};
(b) injection volume of 1 µL;
(c) injector temperature of 250 °C;
(d) heating program: 50 °C for 2 min, 50 to 300 °C (10 °C min^{-1}), hold at 300 °C (5 min), 300 °C to 400 °C (10 °C min^{-1}), hold at 400 °C (5 min), totaling 47 min;
(e) ionization mode, electronic impact at 70 eV;
(f) ion source temperature of 240 °C and interface temperature of 280 °C;
(g) scanned masses from m/z 50 to 1090.

4.3. Results

Traces of lipids are usually absorbed into porous ceramic matrices from unglazed pots. They can be preserved for millennia, undergoing molecular alteration processes that produce characteristic transformation products with typical distribution patterns (or chemical fingerprints) [41]. Knowing the chemical pattern of a given biomolecule or a group of biomolecules allows us to trace the origin of the organic residues and to relate their chemical fingerprints with past human activities [42].

Natural lipids present in both vegetable oils (the fats extracted from plant sources) and animal fats are very rich in triacylglycerol's (TAGs). The partial hydrolysis of TAGs leads to the formation of diacylglycerols (DAGs) and, if the hydrolysis is more pronounced, to monoacylglycerols (MAGs). Their complete hydrolysis produces free fatty acids and glycerol (Figure 6). Therefore, while saturated fatty acids are frequently found in archaeological contexts as end-products of total lipid degradation, acyl lipids as TAGs are only encountered in the best-preserved samples.

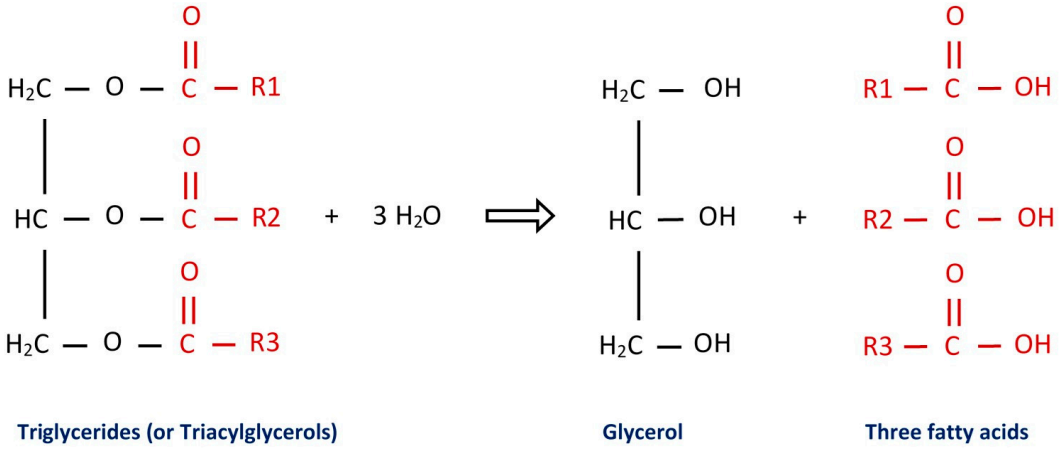

Figure 6. The mechanism of hydrolysis of triacylglycerols.

The chromatogram of this wide horizontal rim vessel (Figure 7) suggests the presence of lipid residues, as it clearly displays intense peaks of TAG degradation products [43–45], as follows:

- Diacylglycerols, such as 1,2-dipalmitin, 1,3-dipalmitin, 1,3-distearin, and a mixture of 1,2- and 1,3-isomers of hexadecanoyloctadecanoyl-glycerol;
- Monoacylglycerols, such as 1-monostearin, 1-monopalmitin (the most intense detected peak), 2- monopalmitin, 2- monostearin;
- Fatty acids, such as the strong peaks of palmitic and stearic acids;
- Glycerol.

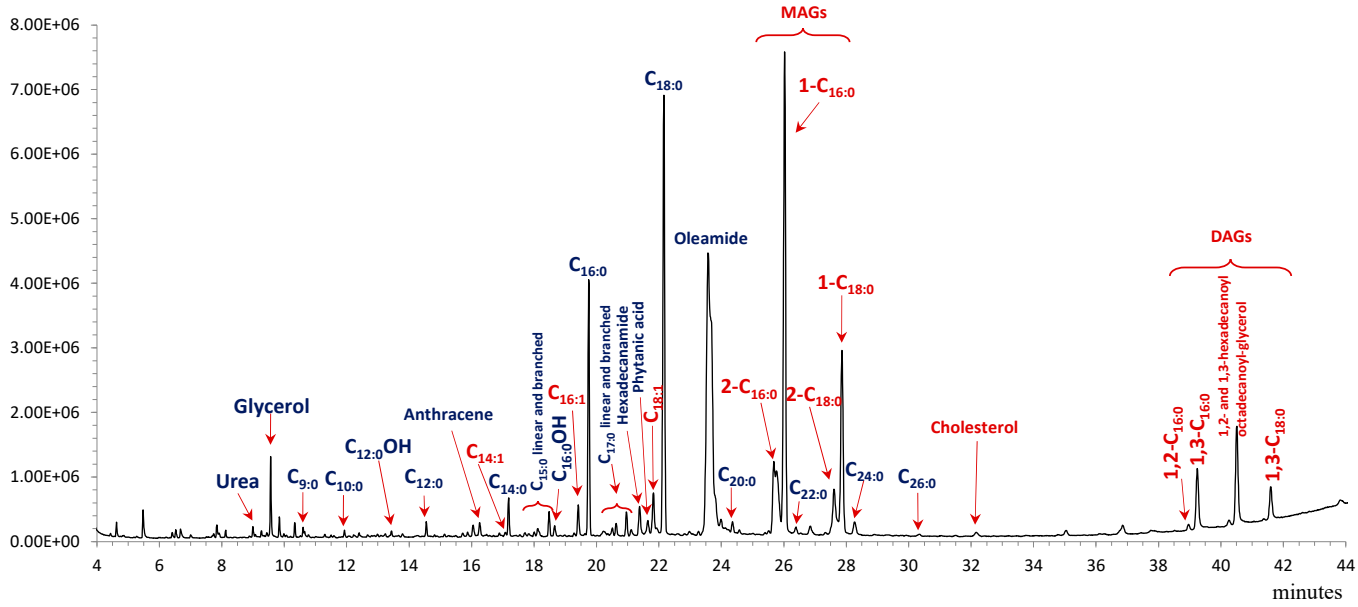

Figure 7. Gas chromatogram obtained from the total lipids extract. Cn:x, fatty acids with carbon length n and number of unsaturation x.

The ratio of palmitic (C16:0) to stearic (C18:0) acids (P/S) allows speculation as to the origin of the fats. In fact, although both palmitic and stearic acids can be found in animal and plant fats, stearic acid is present in higher concentration in terrestrial animals while palmitic acid is predominate in aquatic and plant food sources [43].

The sample presents a P/S ratio of 0.49, suggesting a very strong contribution of animal fat, as a P/S ratio lower than 1.3 can be considered indicative of ruminant adipose fats [43,46]. However, it should be noted that palmitic acid is more water soluble than stearic acid and is therefore preferentially leached from pottery into the surrounding soil, which can cause an artificial decrease in the P/S ratio [47]. Consequently, this diagnostic ratio may not be constant over archaeological time and should be interpreted with caution.

This fact is supported by the presence of cholesterol, an additional biomarker for animal fats. It is vital to stress the absence of squalene, which would suggest the contamination of the sample through mishandling of the ceramic material. In fact, the manipulation of ceramics without gloves introduces lipid contaminants from human skin. Those fats contain both cholesterol and squalene, which can be mistaken for the animal organic residues preserved in the vessels. However, in contrast with cholesterol that resists degradation, squalene is rapidly degraded and, therefore, its detection is usually assigned to modern handling.

The GC-MS analysis showed an almost complete homologous series of n-alkanoic acids (C6–C26), with a higher frequency of straight-chain compounds with even numbers of carbon atoms (C18 > C16 > C17 > C15 > C24 > C20) (Figure 8). It is important to consider the high intensity of the odd linear acids C17 and C15, as well as their branched-chain counterparts. The presence of branched-chain fatty acids and odd carbon-numbered straight-chain fatty acids (such as C15 and C17) has been considered evidence for ruminant animal fats, since these compounds are produced by rumen bacteria [48,49] and are, therefore, biomarkers for ruminant fats.

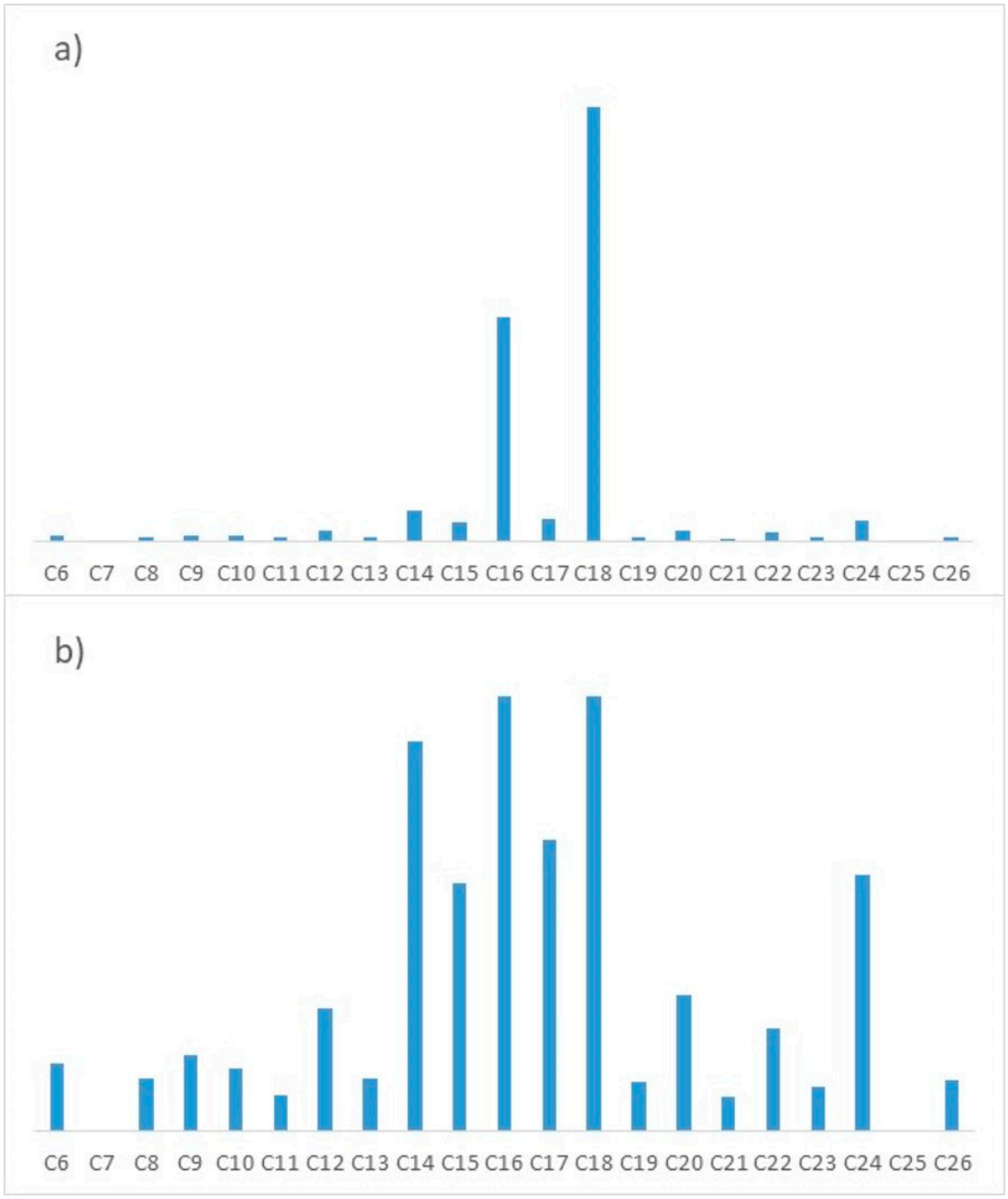

Figure 8. The distribution of n-alkanoic acids. (**a**) illustrates the stronger predominance of C18 and C16 while (**b**) details the less prevalent n-alkanoic acids. Cn is the carbon number.

The presence of phytanic acid supports this hypothesis as this compound can also be found in high concentrations in ruminant animal tissues and in dairy products, being formed in the rumen by bacterial oxidation and hydrogenation of phytol [50].

Several monounsaturated fatty acids were also detected; myristoleic (C14:1), palmitelaidic (C16:1), and oleic (C18:1). These unsaturated acids are found in vegetable oils such as olive oil, sesame or sunflower oils, and almond, walnut, acorn or chestnut residues [51–53], suggesting a mixture of vegetable oils and ruminant animal fats.

The presence of urea and other nitrogen-rich compounds, such as benzamide and hexadecanamide, relates to the cooking of meat, a fact that seems aligned with the clear evidence of the exposure of this vessel to fire. The large number of proteins and amino acids present in meat can explain these high levels of nitrogen. Therefore, when meat is exposed to high temperatures, such as those that occur during cooking, nitrogen-rich

compounds are produced, as amides, N-heterocyclic and N-aromatic compounds [54,55]. The additional detection of anthracene and vanillin, produced during the pyrolysis of lignin during cooking [55], supports this conclusion.

In summary, we detected traces of degraded ruminant fats together with vegetable oil residues. The nitrogen-rich compounds, as well as traces of the pyrolysis of lignin, suggest that the mixture in the Wide Horizontal Rim vessel was exposed to fire.

5. Discussion

Whilst not losing sight of the previously noted constraints inherent to the study of this vessel, and assessing what was possible to observe, it is now crucial to comment further.

The investigation of WHR vessels became more consistent from the end of the 20th century, with the first radiocarbon dating, when contexts and the excavation of some settlements became more valued, allowing for the application of secure stratigraphy where this pottery type appears. Based on the first information obtained from excavations at the Sola and Bouça do Frade settlements, this type of vessel dates from the 2nd millennium BC, the Middle and Late Bronze Age, respectively [12,13] (see also Section 1).

In addition, the results of radiocarbon dating to bone remains from one of the graves of Agra de Antas (Esposende) are of equally significant importance, indicating the early stages of the Final Bronze Age (circa 1400–800 B.C.) [4,5] (pp. 149 and 150). More recent works provided relevant information on radiocarbon chronology for these vessels and their contexts, specifically Quinta do Amorim and Pego (Braga), Faísca (Guimarães) and Corvilho (Santo Tirso) [15,16,56]. Of particular relevance is the dating made directly to the soot found in the vessel from the plane grave (structure 12) of that first site, whose result points to the beginning of the 17th century B.C. [15] (p. 432).

In fact, and although all the already published results as a whole cover distinct stages of the 2nd millennium B.C., from the Early Bronze Age to the beginning of the Final Bronze Age, a certain prevalence of those converging on the second quarter of the 2nd millennium B.C., i.e., the Middle Bronze Age, is made clear [15] (p. 640). Without expressing prejudice to a wide chronology, if not of production, at least of usage, which reaches the Final Bronze Age, it is important not to lose sight of the diverse meaning and nature of the samples used for C14 dating. Elements such as soot in vessels, human bone remains and coal, with variable lifetimes that the analyses results mimic are aspects of reality that should be present in the subjacent interpretations. In any case, we cannot rule out the possibility—it is only a hypothesis—that the viability of the WHR vessels can be apparent throughout different generations, expressing a certain archaism and some meaning as reference elements in identity terms, of familiar or communitarian nature.

This type of pottery is also distinguishable by the remarkable diversity of contexts with which it is associated. In addition to the common ware ceramics found in different sites and distinct geomorphological locations, there are also ceramics with funerary purposes. Those materials are associated with different types of sites and funerary rituals, or other contexts with a ritual nature, such as cists without tumulus, small depressions (“covachos”), plane graves, pits, reused graves with tumulus, settlements and contexts of an indeterminate nature [4] (pp. 7–9), a problematic feature that was clearly presented and systematized by Nonat and co-authors [17] (pp. 71–84). Other works provided relevant information, especially of funerary scope [15,16].

It is obvious that we include the vessel currently being studied in this last category–of indeterminate nature. Even so, and always within the margin of uncertainty in which part of this study took place, we think it is safe to elaborate further, mainly considering the vessel’s state of preservation.

As we have seen, it remains almost entirely intact, which is consistent with a ritual deposition, whether of specific funerary nature or not. It is in these cases, in contrast with inhabited sites where pottery fragments prevail, that we usually find complete vessels or those with little fragmentation. In this case, the two fissures noted on the rim could result from the pressure of the sediments or other post-depositional factors.

A second argument, equally important, supports the hypothesis of an intentional deposition; this is the presence of soot and, in particular, traces of organic residues in the vessel's interior. We insist on this distinction because not all cases which have soot (of increased frequency, and which could simply indicate heat usage in habitational or other contexts, or could even have been obtained at a post-depositional stage) also preserve residues. These expressions sometimes become synonymous but should not be viewed as such. As noted, the presence of substance residues is recurrent in vessels from funerary contexts [8] (p. 77), [11] (p. 39), [14] (p. 673), [16] (p. 101), [27], a pattern that was also confirmed in the case of those specimens of diverse funerary and ritual contexts studied by Sampaio and Bettencourt [16]. Therefore, we can conclude that the vessel presently studied is of funerary or ritual nature. Archaeometry does not unequivocally prove this interpretation but does support it.

The chromatography analyses were very rewarding, since the composition of the organic residues associated with WHR vessels was hitherto completely unknown, as the previous attempts resulted from infrared analysis and not from chromatographic studies and were insufficient to identify the adhering substance [15] (pp. 346 and 639), [26]. It is important to stress that this study highlights some general hypotheses, such as vegetal (resins and waxes) and animal (fat and viscera) substances, whose use lacks a proper archaeological justification.

We are aware that our analyses were not carried out in an ideal scenario, since they should have been accompanied by other control analyses (eventual contamination sensing) of the sediments related to their context, a protocol insisted upon by some researchers [57]. Nevertheless, as was stated before, chromatograms were screened for the presence of common organic contaminants, which were not detected. The achieved results were very clear: traces of degraded fats consistent with ruminant animal fat were detected; the presence of unsaturated fatty acids indicates the presence of vegetable oil residues. In turn, the detection of nitrogen-rich compounds, as well as traces of lignin burn, suggests the mixture was heated in the vessel. What could these results mean? It is difficult to answer unequivocally.

In fact, traces of heated animal fat, along with traces of burnt wood, allow for different hypothesis, such as waterproofing or the use of the vessel for the preparation of meat. In our opinion, the first hypothesis has little support inasmuch as pottery waterproofing entails a rather more homogenous surface treatment, if not total, at least applied to the lower half of the containers. This is the opposite of what is observed in the vessel we studied, in which the organic residues (and not mere soot) are concentrated in and around the rim, solely on the interior side.

As previously mentioned, this is a recurrent effect in a number of WHR vessels, which also have, in a very expressive way, those residues positioned more or less opposite the handle [4,6,8,17,27]. More recent studies, either from the Minho region or from Galicia, confirm that the majority of vessels, either complete or almost complete, follow this pattern [15] (pp. 636, 648); [17] (p. 101).

Concerning the pieces found in funerary contexts, there seems to be a consistent tendency towards the previous manipulation of these vessels using fire before their deposition. In an interpretative exercise, the previously mentioned researchers point to three distinct stages: the vessel would be placed in a vertical position on the fire, would then be tilted on the side opposite the handle, and would later be partially oriented towards the base, still tilted; only then the partial or integral combustion of the substances would occur [17] (p. 102). A somewhat different interpretation, because it presumes movement from the actors who intervened in the associated practices or ceremonies, was considered by the researchers from the University of the Minho [15] (pp. 346 and 684); [27] (p. 131). In addition, admitting that the soot could have been caused by the handling of the vessels during funerary ceremonies, the overflow of their contents could result from the movement action, by walking for example, with the vessel slightly tilted, or, alternatively, as a result of the intentional spillage associated with ritual practices.

These hypotheses seem plausible. For a walk with the vessel slightly tilted, a recurrent performative attitude (i.e., repeated, ritualized) could be seen. The intentional content spillage would be compatible with the tilt of the vessel while holding the handle. However, in this case, and notwithstanding the recurrent concentration of residues on the area opposite to the handle, we have to recognize that this specific shape of the rim, very wide, is not at all suitable to pour semi-liquid or semi-pasty substances.

This discussion would benefit from knowing more about the substance(s) whose residues remain on the other WHR vessels. Would they all have had the same nature, i.e., animal fat, vegetable oil, and traces of lignin burn, in combination, as identified on the vessel currently being studied? If they were, it would be yet another factor in the standardization of this pottery category: the same shapes and the same burnt substances, as well as their incidence on the vessels' topography and in terms of their nature. Unfortunately, any exercise concerning this last realm is not possible to make at this time because of the lack of data regarding WHR vessels (we are grateful to one of the reviewers of this text for the information that "there is a collection of samples for analysis at the D. Diogo de Sousa Museum", when they are published, they will be of great interest for the discussion of this issue).

The mixture of animal and vegetable oils, with a predominance of the former, associated with traces of lignin burn, could suggest its use as fuel. Therefore, we do not rule out the possibility that these vessels were involved in some cases where, along with the ritual manipulation of fire, symbolic practices took place in which illumination played a role, directed more towards a specific area, and implying, with such focus, a tilt in the vessel and consequent spillage. Moreover, the hypothesis that these vessels served as a place to burn a wick soaked in oil was also put forward by Mário Cardozo, while recognizing, however, that the shape of the lower part of the vessels was scarcely suitable for that [8]. He later settled on a proposal, which other authors have followed, that the content would have corresponded to food residues [8,14].

The use of mixtures of animal fats and vegetable oils as illumination fuels is not new, with later parallels for these mixtures found in Roman oil lamps (Lucerne) [58–60]. In fact, there are many reports of the use of animal fat mixtures with different vegetable oils, such as olive oil, radish seed oils, castor oil, sesame seed or linseed oils, amongst others. The great innovation of this work–the unprecedented chemical data concerning the contents of WHR–prevents a direct comparison of these results with any other. However, we emphasize some parallels between the results obtained here with others relating to two pottery vessels of the Bronze Age (Cogotas I) [61]. Although being a very distinct pottery typology, those results also revealed the presence of animal fat, dairy products, and wheat, suggesting to the authors of said study that the containers in question could have served as an offering in a funerary context.

6. Final Remarks

Comparatively, the vessel we have studied is one of the most "classical" from the category of WHR vessels, which is particularly expressive in the North of Portugal. Due to its paste type (medium), surface treatment (smoothed), decorative location (circumscribed to the rim), and simple shape (semiglobular), it is integrated into the sub-group WHR1 [17] (p. 151). However, its decorative organization, obtained through incisions of variable dimension and intensity, does not have parallels amongst the published vessels. Effectively, in this particular regard we are witnessing, so to speak, a not very canonical composition, revealing above all a certain freedom or irregularity in the design.

With their specificities, this vessel is part of the peculiar group of Bronze Age pottery so characteristic of Galicia and the Minho, whose maximum distribution extends to the line of the Douro. As is well known, this Northwest region of the Iberian Peninsula is characterized, during the Bronze Age, by being widely open to the exterior, specifically to the so-called "Atlantic Bronze Age", with the clear circulation of goods of different nature, crossing (physical and cultural) boundaries.

In contrast to this general tendency throughout the 2nd millennium B.C., the WHR vessels do not cross boundaries. On the contrary, all the later finds have reinforced the consistency of these boundaries, previously established by the first finds. These data appear to reveal the low mobility of the human groups who manipulated WHR pottery; at the same time they suggest a particular identity cohesion of these groups. It is interesting to note (even if it is an objective we do not aim to develop in this present work) that, in comparison, another pottery group broadly contemporary with WHR–that from the world of Cogotas I (and proto-Cogotas)–demonstrates the opposite tendency, breaking free of its nuclear region, the North Meseta, to reach, in all directions and multiple context types, the remaining peninsular territory (including those regions where we find the WHR vessels).

With contexts marked by expressive diversity, when known, those which reveal, explicit or implicitly, a funerary or ritual nature stand out amongst the WHR vessels, distancing themselves from daily practices. This circumstance, associated with their inherent stylistic characteristics and the fact that many of them, as is the case of the example published here, maintain residues of their usage–residues whose nature is not specifically dietary–are indicators of the importance they (or at least some of them) had as operating instruments in the reproduction of social strategies of intra and inter-groups bound to the Peninsular Northwest, as "symbols in action" [62]. In this sense, more than a purely functional use, the WHR vessels may be distinguished for their social and ideological functions.

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