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LATE ROMAN AND EARLY ISLAMIC GLASS IN SPAIN: PRODUCTION AND CONSUMPTION

INTRODUCTION

Roman glass typologies in Spain are relatively well established[1], while later periods have not been studied in any detail. The lack of research is even more pronounced with regard to chemical compositions, despite the fact that some of the earliest analyses of Roman glass were carried out in Spain[2]. Our knowledge of glass compositions in medieval Spain has increased over the last few years thanks to new research initiatives[3]. In this paper, we synthesize the current state-of-the-art and future perspectives of the study of glass in late Roman and early medieval Spain, drawing particularly on the results from our on-going research project and published data. Within the scope of our current project *GlassRoutes*, we have carefully selected glass finds from well-dated archaeological contexts spanning the fourth to twelfth century CE and from different geographical and cultural environments in order to capture the totality of glass finds encountered in the Iberian Peninsula during this period. This is work in progress, but we can already identify some major patterns in the consumption of glass across time and what appears to be the first primary production of genuinely Iberian glass.

THE NATRON GLASS

Up to now, we have analysed the typology and composition of more than one thousand samples of natron-type glass objects. They include a large number of late Roman and early medieval vessels and tesserae from various sites dating from the fourth to ninth century CE. A substantial number stems from Alicante on the eastern coast of Spain like the

1 SÁNCHEZ 2018, 377–390.
2 RUA 1864, 45–54.
3 CARMONA et al. 2009, DUCKWORTH 2017, SÁNCHEZ 2018, and our own project *GlassRoutes*.

Fig. 1: Map of glass groups identified in the Iberian Peninsula. References to data analyzed prior to 2017 in De JUAN and SCHIBILLE 2017b. Other analyses in: DE JUAN and SCHIBILLE 2017a, DE JUAN et al. 2018a, 2018b, DE JUAN, SCHIBILLE, and XIMENEZ 2018, DE JUAN et al. 2019.

Roman villas of Baños de la Reina and El Albir, the late Roman fish factory of Picola and the Islamic settlement of Cabezo Pardo[4]. We also investigated glass finds from the central Peninsula, for example, from the Roman villa of Noheda SCHIBILLE et al. 2020 and different Visigothic and early Islamic settlements around Madrid and Toledo such as Gózquez, El Pelícano, Congosto[5] and Recopolis (publication in preparation). Another set of samples without a clear archaeological context comes from later medieval sites at Ciudad de Vascos and Gauzón[6]. Their typological features and clear affiliation with well-established compositional groups allows their attribution to the late Roman or early medieval period (Fig. 1).

On the basis of the available data, early Roman glass compositions in Hispania fit the general trends observed for other areas of the Roman Empire. As elsewhere, glass assemblages are characterised by the presence of Levantine and Egyptian natron-type glass with variable contents of antimony or/and manganese[7]. During the fourth and fifth centuries, the eastern imports reflect significant changes in the compositional characteristics of the glass finds. While our analytical data are still incomplete for the first half of the fourth century, a clear picture is already emerging for the second half of the fourth and early fifth century CE. Similar to other western Mediterranean regions at this time, glass assemblages are almost exclusively composed of the Egyptian high iron, manganese and titanium (HIMT) glass group first defined by Freestone[8]. Of the two sub-groups, HIMTa and HIMTb[9], HIMTa is the main category in fourth- and fifth-century Spain and Portugal. HIMTb dating probably to the beginning of the fifth century has been only detected very sporadically in the Iberian Peninsula, for example, in Braga, Vascos[10], Baños de la Reina and El Alblir (see Fig. 1).

Major transformations of the political and economic systems of the Mediterranean world following the collapse of the Western Roman Empire and the settlement

4 DE JUAN et al. 2018b, DE JUAN, SCHIBILLE, and XIMENEZ 2018, 271–279.
5 DE JUAN et al., 2019.
6 DE JUAN and SCHIBILLE 2017a, 5–7, DE JUAN et al. 2018a, 258–259.
7 DE JUAN and SCHIBILLE 2017b, 6.
8 FREESTONE 1994, 290.
9 CEGLIA et al. 2015, 2017, FREESTONE et al. 2018, 164.
10 DE JUAN et al. 2018b, Table 1.

	wt %												ppm	
	Na_2O	MgO	Al_2O_3	SiO_2	P_2O_5	Cl	K_2O	CaO	TiO_2	MnO	Fe_2O_3	PbO	Sr	Zr
HIMT a (n=51)	18.4	1.03	2.86	65.4	0.04	1.02	0.40	5.95	0.50	2.03	1.96	0.00	449	246
SD	1.0	0.15	0.22	1.7	0.01	0.10	0.07	0.50	0.11	0.22	0.66	0.00	32	62
HIMT b (n=4)	17.5	1.21	3.06	64.6	0.14	1.03	0.48	5.84	0.54	1.81	3.48	0.00	471	212
SD	1.2	0.24	0.28	1.3	0.04	0.20	0.14	0.70	0.12	0.37	0.47	0.00	42	37
Levantine (n=55)	15.1	0.65	3.09	69.6	0.10	0.83	0.65	9.18	0.08	0.02	0.51	0.00	439	41
SD	0.9	0.10	0.15	1.6	0.05	0.10	0.21	1.15	0.01	0.00	0.09	0.00	65	5
Foy 2.1 (n=43)	17.1	1.13	2.47	66.3	0.15	0.82	0.77	8.58	0.14	1.31	0.94	0.01	639	73
SD	1.0	0.12	0.16	1.0	0.05	0.06	0.17	0.69	0.01	0.48	0.14	0.02	86	9
Foy 2.1 high Fe (n=19)	17.9	1.29	2.76	64.6	0.23	0.81	0.90	7.66	0.18	1.12	2.27	0.01	618	94
SD	0.9	0.11	0.20	0.8	0.03	0.07	0.13	0.56	0.02	0.34	0.54	0.00	62	12
Foy 2.2 (n=5)	16.1	0.79	2.74	68.4	0.14	0.76	0.94	7.79	0.13	0.65	0.96	0.10	483	69
SD	1.0	0.20	0.35	1.5	0.07	0.13	0.19	0.68	0.04	0.77	0.50	0.05	14	12
Magby (n=25)	16.1	1.90	2.03	64.8	0.38	0.66	1.48	9.29	0.16	1.53	1.37	0.00	795	85
SD	1.0	0.20	0.35	1.5	0.07	0.13	0.19	0.68	0.04	0.77	0.50	0.00	96	21
Egypt II (n=2)	14.0	0.48	2.40	69.3	0.07	1.06	0.34	10.8	0.24	0.38	0.85	0.00	166	162
Plant-ash (n=34)	14.3	3.22	1.82	66.4	0.44	0.96	2.21	8.50	0.09	0.90	0.66	0.29	528	53
SD	2.7	1.03	0.30	2.8	0.14	0.15	0.45	1.59	0.02	0.57	0.18	0.84	192	36
Plant-ash high Al (n=32)	19.0	4.45	4.91	58.7	0.63	1.09	2.33	6.73	0.27	0.50	0.98	0.18	345	146
SD	1.1	0.65	0.98	2.0	0.20	0.12	0.30	0.90	0.04	0.25	0.21	0.25	92	28
Plant-ash high lead (n=6)	5.52	1.11	1.16	40.1	0.37	2.01	0.66	1.96	0.06	0.50	0.58	45.13	69	18
SD	0.74	0.23	0.39	1.5	0.11	0.31	0.23	0.63	0.02	0.34	0.16	2.94	14	4

Table 1: Average compositions and standard deviations (SD) of the identified glass groups. Major and minor elements in wt% oxides, strontium and zirconium [ppm]. Data: HIMTa (DE JUAN et al. 2018b); HIMT b, Egypt II, Plant-ash, Plant-ash High Al and high lead plant-ash (DE JUAN and SCHIBILLE, 2017a); Levantine, Foy 2.1, Foy high Fe and Magby (DE JUAN et al., 2019).

of the Germanic tribes on the Iberian Peninsula resulted in considerable technological changes in the primary production of glass in the second half of the fifth century. The analytical data indicate that at this time HIMT glass ceased to reach the Iberian Peninsula. It was replaced by the so-called Foy 2.1 compositional group likewise of Egyptian origin. This group differs from HIMT in its lower titanium and higher calcium oxides. It has been documented in western Europe in France, Italy and the United Kingdom, where it is dated to the sixth century[11]. Spanish data along with other recent analyses supports a slightly earlier occurrence[12]. Foy 2.1 (high Fe)[13], which has higher iron and associated trace element concentrations, turns up in the archaeological records in the last quarter of the fifth century. A recently recognised high magnesium Byzantine glass type (defined by Schibille as Magby)[14] is yet another related compositional group that has been identified among Iberian glass assemblages dating to the second half of the sixth to about the middle of the seventh century CE. It differs from Foy 2.1 by lower alumina and elevated magnesium and potassium oxide levels that suggest the addition of a plant-ash component to the glass melt (Table 1). Its presence in the Iberian Peninsula as well as in the UK, Italy, Serbia and among Byzantine glass weights[15] confirms that it was more widespread than has previously been assumed and not a local phenomenon.

11 FOY et al. 2003, 55–58, CONTE et al. 2014, 6–20.
12 GLIOZZO et al. 2017, DE JUAN et al., 2019.
13 CEGLIA et al. 2015, 2017.
14 SCHIBILLE et al. 2016, 12.
15 DRAUSCHKE and GREIFF 2010, FREESTONE et al. 2008, SCHIBILLE et al. 2016.

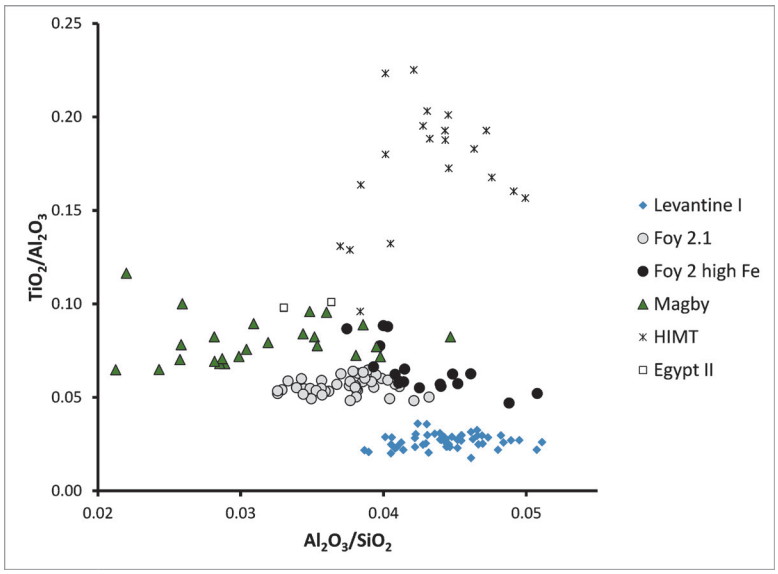

Fig. 2: Natron-type glass groups identified among Iberian assemblages in terms of titanium, aluminium and silicon oxides. Data: HIMT (Picola), DE JUAN et al. 2018b; Levantine, Foy 2.1, Foy high Fe and Magby (Gózquez and Congosto), DE JUAN et al., 2019; Egypt II (Ciudad de Vascos), DE JUAN, Jorge and SCHIBILLE, Nadine, 2017a.

Only few glass fragments attributable to a Levantine Provenance have been identified in Iberia that date to the fourth and fifth centuries. The glass tends to be similar in composition to the vitreous finds from the fourth-century glass factories at Jalame in Israel. Until about the middle of the sixth century, glass finds with a Levantine compositional signature remain limited in the Iberian Peninsula. The situation changes completely in the second half of the century, coinciding with the Byzantine expansion into the western Mediterranean. Levantine I glass related to the sixth- to seventh-century glass from Apollonia (Israel) becomes the most abundant compositional group among Iberian glass finds. Glasses produced on the Levantine coast tend to have lower silica-related heavy metal contaminations than Egyptian glasses[16] (Fig 2). Levantine I constitutes the main proportion of the glass assemblages from the sixth-century Visigothic settlements around Toledo and Recopolis, the city founded by the Visigothic king Leovigild in 578 CE.

Throughout the seventh and early eighth century Levantine imports to the Iberian Peninsula continue. However, glass compositions become increasingly variable and show more and more signs of recycling practices[17]. A notable example of recycled glass is the presence of Foy *série* 2.2 recorded in the eighth-century glass assemblages from Narbonne and Rome[18]. In the Iberian Peninsula only very few fragments from rural settlements around Madrid and Alicante can be attributed to this group[19]. All of them date to the last decade of the seventh or the first half of the eighth century CE. In the late eighth century or early ninth century, Islamic glass of the Egypt II primary production group appears to reach the Iberian Peninsula, albeit in small numbers[20]. Egypt II is easily recognisable due to its low alumina, high lime and low strontium levels together with elevated heavy element concentrations (Table 1). It is the last natron-type glass that was produced in Egypt and production appears to have ceased sometime in the second half of the ninth century[21].

16 SCHIBILLE et al. 2016, 8.

17 DE JUAN et al., 2019.
18 FOY et al. 2003, 60–61.
19 DE JUAN, SCHIBILLE and XIMENEZ 2018, 275, DE JUAN et al., 2019.
20 DE JUAN and SCHIBILLE 2017a, 7; SCHIBILLE et al. 2020b.
21 SCHIBILLE et al. 2019.

From a typological perspective, fourth- and fifth-century glass exhibits a greater homogeneity than during the early Roman period. Tableware was restricted mainly to beakers, bowls and dishes. Fourth-century vessels usually have cracked off rims. Starting in the fifth century, thickened-rounded edges become more abundant. Occasionally they are decorated with applied threads, incised lines or semi-opaque blue cobalt coloured glass drops. These typological patterns are very similar to other contemporary western glass assemblages from Italy, southern France and Tunisia suggesting a shared aesthetic in the manufacture of objects, transmission of skills and the existence of inter-regional trade of finished products[22]. During the sixth and seventh centuries, the trend towards further simplification continues. Cups become more abundant and beakers with blue drop decorations virtually disappear. In contrast, opaque white thread decorations now appear on some vessels mostly dated to the sixth century. Other decorations are few and generally limited to simple incised lines or colourless applied threads.

A drop in vitreous materials appears to occur around the time of the Islamic conquest. Compared to previous centuries, the absolute numbers of glass finds in the archaeological record of the eighth and ninth century is drastically diminished. Typological information is practically inexistent for the eight century and only minor differences can be recognised with respect to late Visigothic glass finds. Some patterns can be discerned from the ninth-century evidence in that the known typologies are reminiscent of contemporary oriental Islamic types. To what extent these represent imports from the eastern Mediterranean, however, cannot be clearly determined at the moment due to a lack of analytical data.

Little is known about the compositional characteristics of mosaic tesserae in Roman and medieval Spain[23]. The most comprehensive analytical study was conducted on the fourth-century floor mosaics found at the Roman villa of Noheda (Cuenca)[24]. In contrast to the prevalence of HIMT glass among utilitarian tableware, only a handful of HIMT glasses were identified among the over 400 tesserae that were analysed. Most of the fourth-century mosaic tesserae from Noheda appear to have been produced from mixed Roman antimony and manganese base glass. As attested elsewhere, some colours (red, green, orange) were produced with a plant ash component. The base glass features as well as the exclusive presence of antimony compounds as opacifying agents reflect a certain archaism in the specialized traditions of making mosaic tesserae.

ISLAMIC PLANT ASH GLASS

Our knowledge about the integration of the Iberian Peninsula into the production and trade systems of Islamic glass from the eastern Mediterranean is very limited. As regards the period under investigation, a small number of samples (69) from Murcia[25], Cordoba, and Málaga[26] have been analysed in recent years, to which we can now add nearly half a thousand samples resulting from our research on the glass finds from Vascos, Albalat, Silves, Alicante, Cordoba and Asturias. It is quite likely that Islamic soda-ash glasses first arrived in the Peninsula in the

22 SÁNCHEZ 2018, 281, DE JUAN et al. 2018b.

23 DE JUAN and SCHIBILLE, 2017b, 6.
24 SCHIBILLE et al., 2020.
25 CARMONA et al. 2009
26 DUCKWORTH et al. 2015, DUCKWORTH 2017.

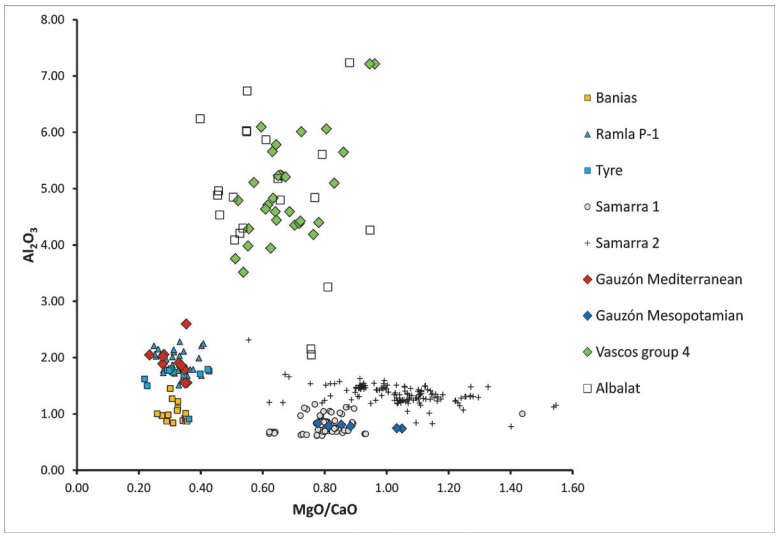

Fig. 3: Aluminium oxide compared with magnesium to calcium ratios of plant ash glass groups from Spain (Albalat, Vascos and Gauzon) in comparison with glasses from Mesopotamia (Samarra) and the Levant (Banias, Ramla and Tyre). Data source: Banias (FREESTONE, GORIN-ROSEN and HUGHES, 2000), Group P-1 of Ramla (Phelps, 2018), Tyre (FREESTONE 2002), Groups 1 and 2 of Samarra (SCHIBILLE et al., 2018), Gauzón (DE JUAN et al., 2018a), Group 4 of Vascos (DE JUAN and SCHIBILLE, 2017) and Albalat (publicacion in preparation).

ninth century but more research is needed to establish exact dates.

The analytical data indicates that by the tenth century, soda-ash glass had completely replaced natron-type glass and made up the vast majority of the Iberian glass assemblages. At least some of this glass can be clearly attributed to a Mesopotamian or eastern Mediterranean origin. Imports of high quality decorated vessels from Mesopotamia and the Levant arrived not only in al-Andalus, but they are also found in the Christian parts of the peninsula. This is evident from the analytical results of the vitreous material from the castle of Gauzón[27] owned by the Castilian-Leonese monarchs where some relief-cut decorated glass vessels present compositional features akin to those of the glass furnaces at Tyre and Ramla (Fig. 3). The fragments with high magnesium to calcium ratios and low quantities of silica-related impurities can instead be linked with the plant-ash glass produced in Mesopotamian and more accurately to Samarra group 1[28].

The analytical study of eleventh- and twelfth-century glass assemblages from the Iberian Peninsula revealed a distinct plant ash glass group that appears to identify a regional production and supply of glass. The earliest occurrence of this glass group cannot yet be determined with precision. It was defined as "group 4" in context of the glass assemblage from Ciudad de Vascos in Toledo[29]. It has distinctively high alumina (> 3.5%), heavy elements and REE contents which clearly distinguish it from contemporary plant ash glasses typically encountered in the Islamic east. This type of plant ash glass has so far only been found on the Iberian Peninsula and its immediate surroundings and its compositional characteristics are similar to some Iberian glasses from the late medieval period[30]. Given its geographical range, it is likely to have been the output of a local production and it may thus be considered as the first entirely locally produced soda ash glass from the Iberian Peninsula. It appears to have been manufactured throughout the eleventh century becoming probably the prevalent glass

27 DE JUAN et al. 2018a, 260–261.

28 SCHIBILLE et al. 2018, 7-8.
29 DE JUAN and SCHIBILLE 2017a, 8–9, 13–14.
30 COUTINHO et al. 2016, 15–16.

composition in the Iberian Peninsula by the second half of the century.

In the tenth to twelve centuries an unusual soda-ash lead glass appears in the archaeological record of the Iberian Peninsula. High lead glass is known from diverse Islamic contexts[31] from Mesopotamia to Morocco, but soda-ash lead glass with high lead (usually 40–50%) and moderate sodium and potassium contents is practically exclusive to al-Andalus. This type of soda-ash lead glass is particularly abundant in Cordoba[32], but has also been recovered from numerous other Iberian places such as Vascos, Murcia, Toledo, Almeria, Albalat, Silves or Gauzon[33] (see Fig. 1). The very distinctive compositional characteristics combined with its relative abundance in the Iberian Peninsula and lead isotope data have shown that these glasses were made from a mixture of silica (maybe glass cullet), soda-rich plant ash and a waste product perhaps from the flourishing lead-silver mining industry around Cordoba[34].

Although there are not many studies on glassware of the tenth and eleventh centuries in the western Mediterranean[35] it is possible to recognize that typologies in the Iberian Peninsula were at that time strongly 'orientalized' and closer to the Islamic east than to European traditions as reflected, for example, in the characteristic mould- and relief-cut decorations[36]. The formal preferences change as well: stemmed goblets disappear and are replaced by beakers with straight walls, and hemispheric bowls and jars with pinched rims increase rapidly in number. These preferences apply to Islamic contexts and Christian kingdoms in the north and east of Iberian Peninsula alike[37].

In Islamic Spain glass was valued as a prestige commodity. It was used in architectural decoration in some of the most prestigious constructions at the time as confirmed by written sources describing its use in the tenth-century caliphal city of Madīnat al-Zahrā' and the eleventh-century palace of the sultan of Toledo[38], or the import of glass tesserae from Byzantium to be used in the Mosque of Cordoba. That these textual sources have a basis in reality is evidenced by the mosaics in the Mosque of Cordoba[39], the remains of glass tesserae recovered during archaeological excavations at Madīnat al-Zahrā'[40] and the recent discovery of horseshoe arches decorated with painted plaster figures and coloured glass from the eleventh century of Toledo[41]. Architectural glass decorations have also been archaeologically attested in the twelfth and thirteenth century in Cieza, Yecla and Murcia[42]. Glass tableware is well represented in elite environments such as palaces or in the principal houses of the main cities, while being rarely present in rural or modest domestic contexts. Nonetheless, it seems that medical purposes were one of most common uses of glass in al-Andalus and it is often quoted in Andalusian medical treatises. Moreover, small unguentaria destined to preserve ointments represent the most common vessel type recovered from

31 SAYRE and SMITH 1961, 1826.
32 DUCKWORTH et al. 2015.
33 DE JUAN and SCHIBILLE 2017b, *Tabla* 1.
34 DE JUAN and SCHIBILLE 2017a, DUCKWORTH et al. 2015, 36, DUCKWORTH 2017, 388–389, SCHIBILLE et al. 2020b.
35 FOY, 2017, 19–29.
36 JIMENEZ 2006, 55–66, DE JUAN and SCHIBILLE, 2020.
37 DE JUAN et al. 2018a.
38 DE JUAN and SCHIBILLE 2018, 476–477.
39 GÓMEZ-MORÓN et al. 2021
40 VALLEJO 2010, Fig. 307.
41 MONZÓN, 2004, 53–54.
42 GONZALEZ, 2014, 213.

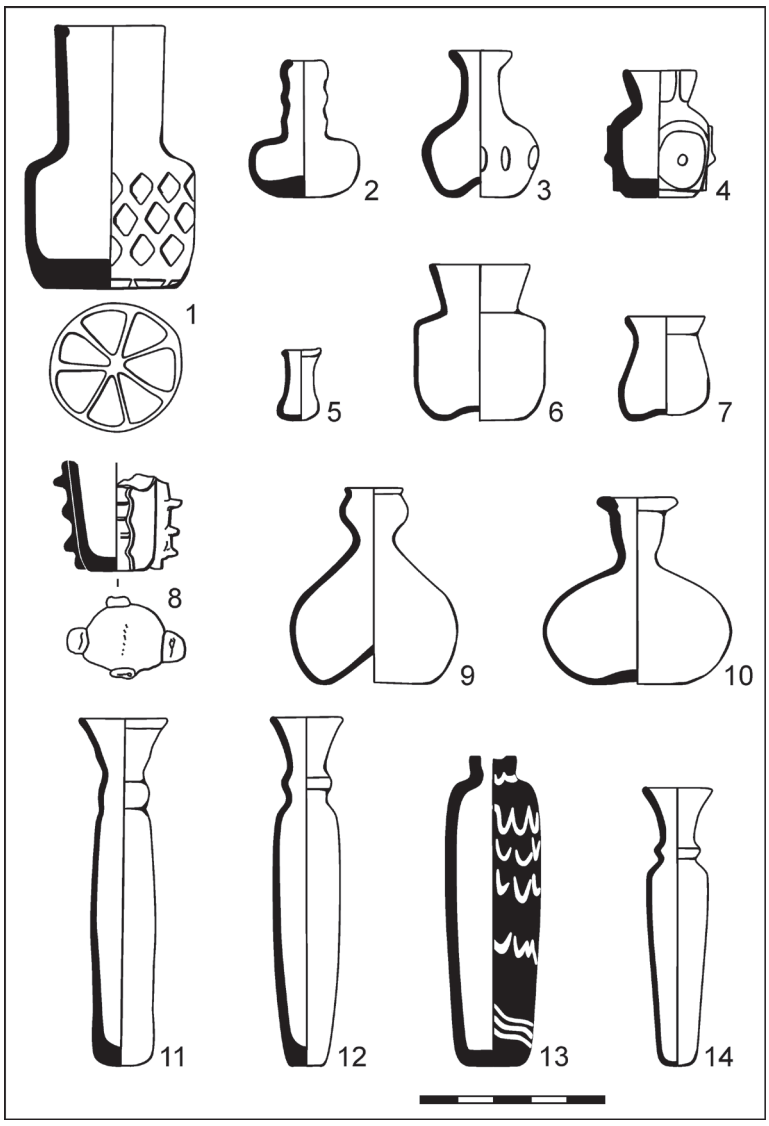

Fig. 4: Drawings of unguentaries from al-Andalus dating to the tenth to early thirteen centuries. Adopted from: (1–4,13) Puig des Molins, CAPELLÀ and RIERA 2015, Figs. 1. 2-3, 5, 7 and Fig. 4.3, (5–8) Ciudad de Vascos, DE JUAN and CÁCERES 2016, Fig. 2. 1,4-5 and 3. 5; 11, (11) Castillo del Río, PUCHE 2000, Fig. 1.4, (9-10) Murcia and Lietor, JIMÉNEZ 2000, Figs. 9.1–2 and Silves (14) GOMES 2015, Fig. 6.

archaeological excavations[43] (Fig. 4). When analysed, their contents appear to correspond to the ingredients described in the written sources. The archaeological and textual evidence thus confirms that in al-Andalus there was an active trade of medicinal and cosmetics products[44].

From the twelfth century onwards glass finds become again more numerous and shapes more diverse. This seems to be related to the expansion of local raw glass production to the detriment of eastern imports. The existence of glass workshops in al-Andalus is documented by reliable written sources from the eleventh century, even though the earliest remains published to date are attributed to the twelfth century[45]. Archaeological evidence of primary glass workshops exists from twelfth-century Seville, Murcia or Almeria. The first reference to a thriving glass industry in the Christian kingdoms is also documented during this period[46]. Written mention of workshops dating to the mid-eighth century has to be assessed with caution as the earliest Arab source that transmits this information dates to the end of eleventh century, three centuries after the events it relates[47].

CONCLUSION

The research into the development of glass consumption, trade and production in the Iberian Peninsula between the fourth and the twelfth century is still ongoing and we

43 DE JUAN and CÁCERES 2016, 9–12.
44 DE JUAN and SCHIBILLE, 2018, 478–480.
45 JIMÉNEZ, MUÑOZ and THIRIOT 2000, 433–452.
46 DE JUAN and SCHIBILLE, 2017b, 199, GUDIOL, 1936, 15–20.
47 DE JUAN and SCHIBILLE, 2018, 475–476.

hope to be able to provide further details on some of the issues raised in the near future. For the time being, we can say that during the late antique and early medieval periods there are close similarities between the glass groups found in the Iberian Peninsula and those from other regions of the western Mediterranean. With this new information, we can start mapping some of the chronological and geographical patterns in more detail. It is clear that the glass trade from the east continued well into the sixth and seventh centuries, and even during the Islamic period we see evidence of imports from the eastern Mediterranean, although to a lesser extent. After the Umayyad conquest in 711 CE, early Islamic Spain evidently maintained close commercial links with the rest of the Islamic world. Not only was soda-ash glass imported from the east, but evidence also appears to indicate the transfer of technological skills. In contrast, the production of distinct types of high lead glass was a regional development, possibly to compensate the lack of imports of eastern raw glass. The compositions of the plant-ash glasses in Iberia began to change also at the end of the first‑millennium CE, pointing to the gradual establishment of a new, specifically Iberian glass industry.

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