POTTERY FROM CRUSADER ACRE: A TYPOLOGICAL AND ANALYTICAL STUDY

Edna J. STERN, S. Yona WAKSMAN

RÉSUMÉ : Des fouilles ont été réalisées à grande échelle par le Service Israélien des Antiquités sur plusieurs sites de Saint-Jean-d'Acre datés des Croisés. Elles ont mis au jour une grande variété de catégories de céramiques locales et importées. Ces céramiques datées du XIIe et surtout du XIIIe siècle montrent une diversité de provenances qui illustre les liens maritimes entre Acre et la Méditerranée orientale et occidentale. Certains types de céramiques levantines et byzantines ont été étudiés en laboratoire, par analyse chimique et par pétrographie. Il apparaît qu'Acre n'est pas le site de production de plusieurs des catégories de céramiques levantines les plus typiques. Des importations byzantines assimilées à la « Zeuxippus Ware » ont été caractérisées, mais le manque de références chimiques d'ateliers médiévaux de Méditerranée orientale restreint les possibilités d'identifier leur provenance.

PART I

Introduction

Acre ('Akko) was an important port city in the Crusader Kingdom of Jerusalem during the 12th and 13th centuries (Fig. 1). The city fell to the Franks in 1104, and it was in their hands until it was captured by Saladin on July 10 1187. With the establishment of the second kingdom (1191), Acre became the capital of the Crusader Kingdom of Jerusalem, because the Franks could not recapture Jerusalem. During this period the city was a thriving commercial center, but this prosperity came to an end in May 1291, when Crusader Acre was captured and destroyed by the Mamluk sultan al-Malik al-Ashraf Khalil. During the Crusader period in Acre, its port was the busiest one in the Frankish East, playing an important role in the maritime trade between Europe, the Crusader Kingdoms and the Moslem states and serving as a gateway for pilgrims coming to visit the Holy Land. Italian merchants, mainly from Genoa, Pisa and Venice, controlled much of these naval activities (Jacoby 1979). Among the various goods that arrived by sea or land to the markets of Acre, were also glazed tableware, cooking ware and amphoras or other ceramic vessels that contained wine, oil, ground sesame, salt and fruits.

Large-scale excavations that have been carried out by the Israel Antiquities Authority at various sites in Crusader Acre since the early 1990s have revealed a great variety of local and imported pottery types dating to the Crusader period (Avissar 1994; 1998; Stern 1999a;1999b; Hartal 1997; Syon 1998). The ceramic finds, dating to the 12th and mainly to the 13th centuries show a diversity of sources that illustrate the maritime connections with the Eastern and Western Mediterranean. A few of these pottery types were subject to an analytical study that will be presented in part II.

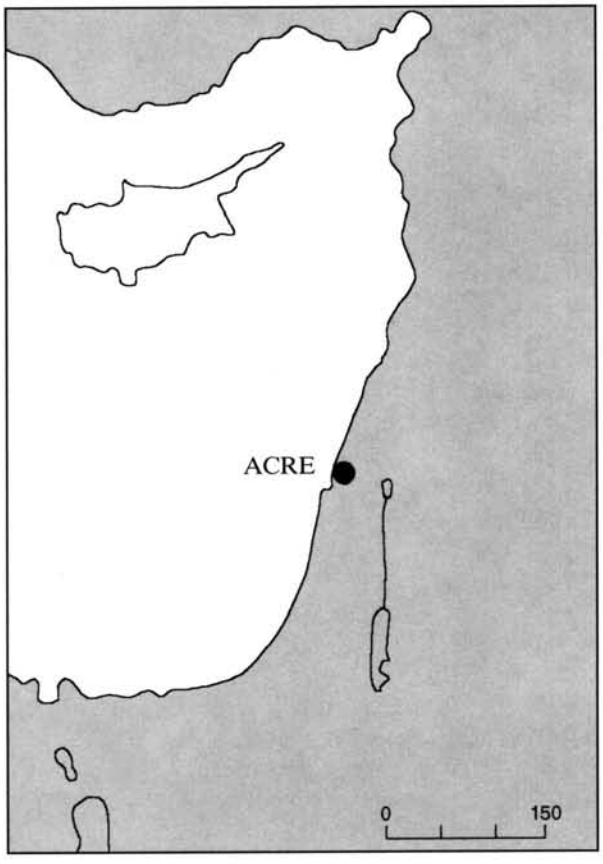


Fig. 1. Location map.

Fig. 2. Local Plain Wares (photo C. Amit, IAA).

The pottery

The pottery assemblage from Crusader Acre consists mainly of glazed tableware, but also of many types of unglazed simple wares, cooking wares and transport amphoras. A relatively small pottery assemblage from an excavation of a Crusader tower has been published (Stern 1997). This is a preliminary presentation of the main finds from the more recent excavations. All the pottery sherds found in these excavations were saved, sorted, and counted according to typological types. The pottery is currently being studied and prepared for final publication.

Local Plain Wares (Fig. 2). Among the unglazed wares a simple bowl of a uniform shape stands out. This type of bowl was found in large quantities in Acre and its close vicinity, and thus it was named "Acre Bowl" (Stern 1997: 37-39). The typical bowls have a short ledge rim, a hemispherical body, and a flat, string-cut base. The fabric is coarse and gritty, light red to reddish brown in color with many grits and inclusions, and all the vessels have a whitish or light colored self-slip.

The coarseness of the fabric and of the potters' workmanship point to the fact that this simple bowl has been mass-produced. Large quantities of these were unearthed in the courtyard of the Hospitallers' compound, and it seems that this type of bowl served the pilgrims and the sick that stayed in the hospice. Over-fired wasters that were found in the Hospitallers' compound and laboratory analysis (see part II) indicate that the "Acre Bowls" were produced locally.

Various other types of plain vessels made of local coarse fabric similar to that of the "Acre Bowls" were found as well. These include open and closed shapes. Among the open shapes are plates with a flat base and a short ledge rim, bowls with simple vertical rims, some having incised decoration on the exterior, thick-walled basins with vertical, thickened or out-folded rims and flat bases. Among the closed shapes are jugs with a simple rim, and a cylinder or funnel shaped neck with ribbing, one handle pulled from the neck to a pear shaped body and a flat base and similarly shaped juglets of a smaller size. Also made of the same fabric are table amphoras with thick out-turned or folded rims, a cylindrical neck with ribbing, handles attached from the lower part of the neck to the shoulder of the pear shaped body. Similarly shaped closed vessels have been found at 'Atlit (Johns 1936: fig. 14.6, 11), Tel Yoqne'am (Avissar 1996: 155, fig. XIII.125) and Tell 'Arqa (Hakimian 1988: fig. 11.9, 13.1). The local workshop apparently also produced functional ceramic vessels for other purposes. The first are the ceramic vessels that were used in the sugar industry, an industry that thrived in the Crusader Kingdom during the 13th century. The production of sugar from sugar cane was accomplished in a

Fig. 3. Levantine Cooking Wares (photo C. Amit, IAA).

few stages, and at the last stage two types of ceramic vessel were used, a conical vessel with a narrow base, ending with a tip and a single hole, and a narrow mouthed, ovoid shaped jar (Stern, forthcoming). The second are antila pots (also known as nuria jars) used to raise water from a well. They are cylinder shaped vessels with a simple rim, a groove below the neck, a rounded body, and a pointed base. Similar vessels were found at 'Atlit (Johns 1936: fig. 14.12) and the Red Tower (Pringle 1986a: 144, fig. 44.25).

Amphoras. In Acre transport amphoras of different types that were imported from the Eastern Mediterranean were found. The dominant type is a vessel with a carrot-shaped body, high, narrow neck and two handles that rise above the rim. The upper part of the body has a crude combed pattern, and the walls are very thick (Stern 1997: 38-40, fig. 4.10-12). This type has variations in size and body shape, and is similar to Günsenin Type III and Saraçhane Type 61 (Günsenin 1989: 271-274, fig. 8-10; Hayes 1992: 76, fig. 26.10). A second type of amphora, similar to Günsenin Type IV and Saraçhane Type 62 (Günsenin 1989: 274-276, fig. 12-14; Hayes 1992: 76, fig. 24.12-13), has a wide globular body, low neck that ends in a thin rim that two heavy handles merge with. The fabric is fine and hard, light reddish brown in color, and shallow ribbing over the body. A third type is of an elongated body, long, narrow cylindrical neck and two handles that extend from slightly below the rim to the shoulder. This type is less known than the former two, and was found in Istanbul (Saraçhane Type 65, Hayes 1992: 76, fig. 26.6), and in Serbia (Popović 1989: 128-130, fig. 6.1-2). A fourth type that may be of a Levantine origin was found as well. This vessel has a thick rim with a ridge below, a high and narrow neck, two thick handles starting from the upper part of the neck and connected to the shoulder, and a body tapering from the shoulder to the flat base. This type is known only from Acre and Caesarea (Stern 1997: 39-40, fig. 4.13-14). Some other types of amphoras of unknown types were found as well.

Levantine Cooking Wares (Fig. 3). The cooking ware assemblage unearthed in the excavations in Acre comprises mainly of the Levantine type that continued the local cooking ware tradition of the Early Islamic period.

Two major types of local cooking wares are evident in Acre: closed globular cooking pots with various rim shapes, and open shallow baking dishes with simple rims. These two types appear in two dichotomous fabric groups, each with its respective glaze. Group 1 fabric is fine and is hard and metallic. It is used for thin-walled vessels; its glaze is very glossy and appears dark purple on the fabric, covers the interior of the base, sometimes with splashes in and out. Group 2 fabric is coarse and sandy. It is used for thick-walled vessels; its glaze is thick and appears brown to

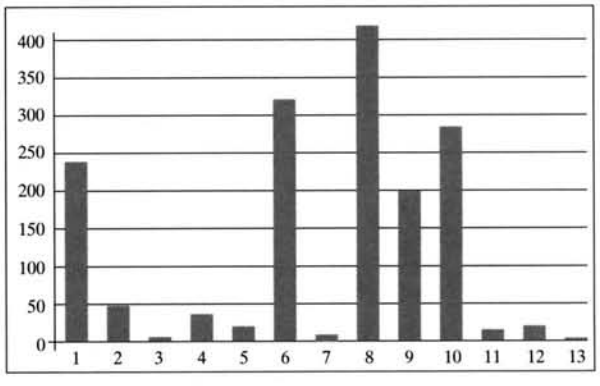
dark orange on the fabric, covers the whole interior, up to, and including the rim. Both fabric groups have the same color – red, and the same temper – some small white grits. Such types of cooking wares are common in various Crusader period sites in Israel and Lebanon, and were found in Cyprus as well (for example see: Stern 1997: 40-43, fig. 5; Avissar 1996: 135-136, fig. XIII.93-XIII.96; Salamé-Sarkis 1980: 214-216, fig. 37-38; Megaw 1971: 123-125, fig. 2.7, 3.5). According to the results of the analytical study, the local cooking ware seems to have been manufactured in the Levant, although not in Acre itself (see part II).

Imported Cooking Wares. Some types of imported cooking wares from different parts of the Mediterranean were found but are less common than the Levantine cooking wares. The origin of four groups has been identified so far. A few additional types of cooking wares, from unknown provenances, were found as well, and will not be described here.

The first group has typological parallels in Cyprus; it consists of cooking pots that are handmade, globular, with relatively thin walls, an everted rim and a broad strap handle pulled from the rim to the shoulder (Stern 1997: 42-43, fig. 5.37; Flourentzos 1994: 12-13, pl. 22.51, 24.52, 53). Petrographic analysis showed that this type is foreign to the area of Acre and its surroundings and may have come from Cyprus (Goren 1997: 72-73). The next two groups surprisingly appear as imports from the Western Mediterranean, and may have arrived to the port of Acre with the Marseilles merchants, who took an active part in the Levant trade (Abulafia 1980). These two groups were not reported to have been found up till now in the Levant, and their presence in Acre demonstrates the close ties between this port and Marseilles. One group comprises of closed globular cooking pots, and a shallow, wide mouthed vessel, which occasionally has a spout. The fabric of these vessels is fine, contains kaolin, and is white, beige or pink in color. The walls are relatively thin, and the interior is covered with a distinctive glossy yellow lead glaze. This type is well known from various sites in Provence and Languedoc, where production sites have been identified (Leenhardt 1996: 108-120, fig. 11-20). The other group was probably imported from France and is also known from various sites in Provence and Languedoc. The shape of the pots is globular, an out-turned simple rim and a flattened, slightly convex base. The walls are thick on the upper part of the vessels, and thinner towards the base. The fabric is coarse, dark reddish brown to dark grayish brown in color and is tempered with many inclusions as calcite, quartz, grog and mica (Vallauri 1997: 66-68, fig. 43). A fourth group of shallow baking dishes with a simple rim, flattened base and knob or ledge handles probably comes from Liguria in Italy, and may have arrived to the port of Acre with the Genoese merchants, who also took an active part in the Levant trade to Acre. The vessels are thick-walled, coarse, with brick-red fabric and a transparent lead glaze covering the interior (Vallauri 1997: 86, fig. 59.1-11). These four types seem to be imported to Acre according to the fact that the appearance of the fabric is very different from the local and Levantine fabrics, and according to their typological similarity with western productions, as shown above. However, scientific analysis would be needed to confirm if these types were imported from Western Mediterranean or not.

Glazed Tableware. At the Acre excavations a large variety of glazed tableware dating to the Crusader period was found. These types of glazed wares are well known from other sites around the Mediterranean basin, and some of the types can be found at sites such as Alexandria, Paphos, Port St Symeon, Corinth and Marseilles. Acre differs from these sites in the large variety of the glazed pottery types coming from different provenances. This unique phenomenon is explained by the important role that Acre assumed in international trade during the 13th century. Figure 4 presents the quantities of glazed pottery that was found in one of the excavations in Acre of a domestic and commercial quarter (Syon 1998; the quantities of glazed bowls was obtained by counting rims only). It is obvious from the chart that the imported glazed wares (Fig. 4.3-13) outnumber the Levantine and Islamic glazed wares (Fig. 4.1-2).

Levantine Glazed Bowls (Fig. 5). Among the glazed bowls are bowls that are glazed in monochrome or decorated with slip-painted, sgraffito and reserved slip techniques.



1. Levantine Glazed Bowls
2. Islamic Glazed Bowls
3. Byzantine Fine Wares
4. Aegean Wares
5. Zeuxippus Wares
6. Zeuxippus II-III influenced ware
7. Zeuxippus IV (Spirale-Cerchio)
8. Cypriot 13th-Century Glazed Wares
9. Port St Symeon Wares
10. Proto Maiolica
11. North African Cobalt and Manganese Ware
12. Catalan Green and Brown Ware
13. Chinese Celadon

Fig.4. Glazed pottery from Acre.

Fig. 5. Levantine Glazed Bowls (photo C. Amit, IAA).

The fabric of these bowls is coarse, sandy, brickred in color and contains grits and occasionally large white inclusions. They have low, wide ring bases, and a small and narrow or large and wide ledge rim. According to the results of the analytical study, it seems that these glazed bowls were manufactured in the Levant, but not in Acre (see part II). These bowls are common in various Crusader period sites in Israel and Lebanon (for example, Slip-Painted: Stern 1997: 47-48, fig. 7; Hakimian 1988: 19-20, fig. 10.2. Monochrome and sgraffito: Avissar 1996: 90-93, fig. XIII.22-XIII.26. Reserved slip: Pringle 1985: 179, fig. 4.22-25).

Islamic Glazed Wares. Open and closed vessels made of fritware that were manufactured in Central Syria were found as well. The vessels are painted in black or black and blue under a colorless or turquoise alkaline glaze, mainly with floral designs (Poulsen 1957: 157-182; Stern 1997: 63-65, fig. 17.120-123). These vessels were produced in the Islamic Lands and were used by the Crusaders in Acre. This illustrates well the fact that although Moslems and Christians were in a state of war, the commerce in goods as ceramics continued during this period.

Imported Glazed Bowls. The earliest import seems to be the "Byzantine Fine Wares" (Morgan 1942; Armstrong 1997a). Examples of glazed bowls decorated in sgraffito, slip-painted or painted in green and brown were found in Acre, but only in small quantities (Stern 1997: 65, fig. 17.124). Also found in small quantities are the "Aegean Wares", decorated with sgraffito or green splashes (Megaw 1975; Armstrong 1991: 340-346; Stern 1997: 58, fig. 13.99-101). "Zeuxippus Wares" (Megaw 1968; 1989) and sub-groups of this family were found as well and were part of our analytical study (Fig. 6; see part II). The "prototype" of this family ("Zeuxippus Ware" – class II), made of fine fabric and glossy glaze, was found in small percentages in Acre (Stern 1997: 52-54, fig. 11). Two sub-groups, that I will temporarily name "Zeuxippus influenced ware", are similar in appearance to the Cypriot 13th-century Sgraffito Ware (see below), and to the "Zeuxippus derivative" found in Sparta (Armstrong 1992). The two sub-types from Acre differ from each other in fabric, one being darker, and the second lighter, but according to the results of the analytical study they seem to have been coming from the same source (see part II). Bowls of this type have been found in Acre in very high percentages (Stern 1997: 54-56, fig. 12). Their provenance is still unknown. The fourth sub-group is of a separate typological and fabric group. The clay is red and the glaze is yellow-orange or rarely dark green. The hemispherical bowls are decorated in the inside with incision of a spiral decoration on the

Fig. 6. Zeuxippus Ware: "genuine" – lower row, in the middle –, "influenced ware" – the rest (photo C. Amit, IAA).

base and parallel lines near the rim. A roulette decoration is seen on the exterior of some of the bowls. It seems that these bowls belong to the "Spirale-Cerchio" type produced in Venice, testifying to the tight connections with Venice (Berti 1997: 87-88). This sub-group was also found in small quantities in Acre, and seems to be dated to the end of the 13th century.

"Cypriot 13th-century Sgraffito and Slip-Painted Wares" is one of the most common imports to Acre (Stern 1997: 48-51, fig. 8-10). These bowls and jugs seem to be of the types that were manufactured in the Lemba-Paphos workshops that were recently revealed there (Papanikola-Bakirtzis 1996: 215-218; von Wartburg 1997). "Port St Symeon Wares" were imported to Acre and are among the most common imports as well (Lane 1937: 45-53; Djobadze 1986: 186-198; Hild 1990: 358, fig. 312-315; Stern 1997: 56-58, fig. 13). Nice examples, similar to those found at other sites in Turkey, and decorated with birds, human and hybrid figures as well as shields, geometrical and floral motifs were unearthed. In addition to the well known shapes of bowls, plates and large basins, unique shapes of jugs and holemouth vessels from this ware were found as well.

"Proto Maiolica" Ware from Southern Italy and Sicily was also one of the most common imports (Whitehouse 1980; Stern 1997: 58-63, fig. 14-16). Different shaped vessels, bowls, plates and jugs were found, decorated in variations of geometrical, floral or figural designs. The most common types are of the "Brindisi Ware" and the "Gela Ware". A type that appears rarely in Acre, and seems to be related to the "Gela Ware" by the shape of the vessels and the fabric, is decorated with human figures, geometrical and floral designs painted in brown paint only. "North African Cobalt and Manganese Ware", manufactured in Tunis was found in Acre in small quantities (François 1999: 99-101, fig. 22-23). This type consists of bowls, basins and closed vessels with thick walls of light fabric, coarsely potted and glazed with patterns painted in blue and brown tin glaze on a white background.

Two other types appear only in small quantities in Acre and apparently were imported at the end of the 13th century. The first are glazed bowls and albarellos with a roulette decoration on the exteriors that apparently were produced in Venice, and belong to the "Roulette Ware" type (Gelichi 1984). The second type are tin-glazed bowls with brown and green painted decorations imported from the area of Catalonia in Spain (Démians d'Archimbaud 1980: 34, pl. IX; François 1999: 85, fig. 20.210-218). Catalan merchants, who were engaged in the trade of grain from Sicily to Acre in the year 1282, may have brought these glazed bowls on their ships (Ashtor 1984: 283-284).

The most unique glazed bowls that were found in Acre are Chinese celadon bowls dated to the 13th century, that are made of fine light gray stoneware and covered with a thick coat of shiny opaque green-gray glaze that covers all of the vessels except the base. In color and texture the glaze resembles jade. Some very fine examples were found, decorated with carved lotus petals on the exterior. This type of celadon was first manufactured under the Sung dynasty in the southern part of China, and is known as southern celadon or as Lung-ch'üan celadon (Medley 1989: 145-146). Acre was a transit port for exporting the celadon to the west, mainly by Italian merchants. It seems that this ware was also in the use of the people of Acre, as attested by the fact that it was found at two different sites in the city.

This was just a quick glimpse of the richness of the ce-

ramic assemblage that was found in recent excavations in Acre. This assemblage reflects the cosmopolitan character of Crusader Acre and contributes greatly to the study of the circulation of wares around the Mediterranean.

(by Edna J. Stern)

PART II

Laboratory investigations

This part of the paper sums up the results of a program of chemical and petrographic analysis undertaken on part of the ceramics material excavated in Acre, which are presented elsewhere in more details (Waksman 1999; forthcoming b). Even though our study was comparatively designed on an extensive scale, it could only investigate a few types of wares and focused on two categories: typical Levantine wares and imports related to the Byzantine type "Zeuxippus Ware". Chemical and petrographic analysis have been extensively used in the past decades to investigate the provenance of ceramics. This investigation is based on the comparison of their characteristics as determined by analysis with those of ceramics of known origin or with the ones of geological formations. Still, very few analytical studies were devoted to Medieval wares in the Eastern Mediterranean area (Waksman, forthcoming a; Armstrong 1997b). The pioneer work of Megaw and Jones (Megaw 1983), currently updated and extended by Armstrong and Hatcher (Armstrong 1997b), is a noticeable exception with the characterization of several productions from attested workshops. As for the analytical studies specifically focusing on Medieval wares in the Frankish Levant, Frierman's early exploratory paper may be quoted (Frierman 1967). But it is not, as far as we know, until Boas's work (Boas 1991; 1994) that chemical analysis was extensively applied to wares found in the Crusader states. Boas's main concern was imported wares, and his attempts to provenance them led to both interesting and controversial results (cf. *infra*). Also noticeable is the study by Goren (Goren 1997) who proposed possible areas of provenance for a selection of Medieval wares found in Acre according to their petrographic features and may be considered as preliminary to our own study.

Both petrographic and chemical analysis, by ICP-AES and ICP-MS (Inductively Coupled Plasma – Atomic Emission Spectrometry and – Mass Spectrometry), were used in the framework of this work. Analyses were carried out in the Geological Survey of Israel, with the collaboration of Irina Segal and of Naomi Porat who took care of the petrographic study. Additional chemical data were obtained by INAA (Instrumental Neutron Activation Analysis) in the Archaeometry Laboratory of the Hebrew University. 23 elements, including major and minor constituants of ceramics pastes (Na_2O, MgO, Al_2O_3, K_2O, CaO, TiO_2, MnO, Fe_2O_3) and 16 trace elements (V, Cr, Ni, Sr, Y, Ba, La, Ce, Nd, Sm, Eu, Tb, Yb, Lu, Th, U) were altogether determined (Waksman 1999). Chemical data were submitted to multivariate statistical treatments in order to classify the samples into groups of similar chemical composition.

"Levantine" Wares

Our first scope was to investigate some categories of wares very common in Levantine sites at the Crusader period: sgraffito, slip-painted and reserved-slip bowls (Fig. 5) and glazed cooking wares (Fig. 3). Since the 1980s, greater attention has been given to these ceramics that are expected to be Levantine productions according to their distribution, even though quite a few of them were found in Cyprus (see part I for references) and some maybe as far as Marseilles (Démians d'Archimbaud, this volume; Waksman in François, this volume). Still, little is known about the workshops and the patterns of diffusion of their products, and about the way these features may have evolved at the arrival of the Westerners and during the Frankish period. A small contribution to the question could be expected through the study of Acre both as a main coastal Crusader site and as a production site of ceramics.

Evidence of local production is brought by the discovery of wasters of a simple, unglazed type of bowl named "Acre Bowl" (Fig. 2) among the excavated material. A street of cooking-pots makers in 13th-century Acre is also mentioned in texts (Pringle 1986b: 470) though, as Pringle notes, "whether these craftmen were working in clay or metal is less certain". It was thus seen as an important task to define a new analytical reference group corresponding to this production and to investigate the range of products – within the limitations of our sampling – which were manufactured in Acre at the Crusader period.

The classification of about a hundred samples (wasters, Acre bowls, sgraffito, slip-painted and reserved-slip bowls and cooking pots) according to their chemical composition resulted in five main groups (Fig. 7 and Table 1). Figure 7 shows the dendrogram obtained by hierarchical clustering analysis on the normalized concentrations of 18 elements. In a dendrogram, samples are represented at the bottom each by a vertical bar and are gradually linked into clusters of similar chemical composition, the height of the horizontal links being proportional to the degree of chemical similarity (e.g. Picon 1984).

The picture that emerges is that, within our sampling, only the Acre bowls proved to have been locally manufactured. Acre bowls and wasters actually constitute a quite

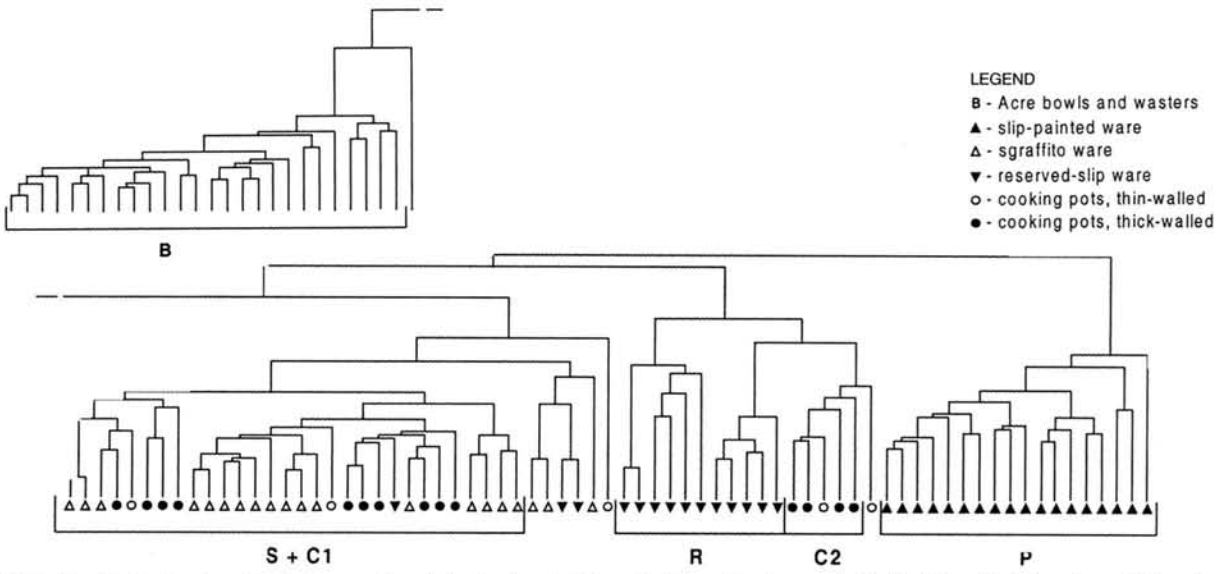


Fig. 7. Classification based on chemical composition of Acre bowls and of Levantine Wares. Dendrogram obtained by hierarchical clustering analysis on the normalized concentrations of 18 elements. Typological categories are represented by symbols (cf. legend). The main compositional groups are underlined (drawing M. Vichy, Laboratoire de Céramologie Lyon).

	group B "Acre bowls"		group P slip-painted ware		group S+C1 sgraffito ware and cooking pots		group C2 cooking pots		group R reserved-slip ware	
	m	σ	m	σ	m	σ	m	σ	m	σ
n	26		17		24		5		11	
Na_2O (%)	1.32	0.28	0.36	0.10	0.15	0.04	0.23	0.07	0.17	0.03
MgO (%)	3.19	0.48	0.46	0.20	0.67	0.13	0.93	0.22	0.84	0.23
Al_2O_3 (%)	13.34	1.33	14.92	0.88	11.40	1.08	13.63	1.33	17.96	1.15
K_2O (%)	1.70	0.28	1.48	0.25	0.53	0.12	0.84	0.22	1.38	0.32
CaO (%)	8.02	1.74	9.25	1.88	3.93	2.72	1.66	0.37	2.13	1.67
TiO_2 (%)	1.19	0.08	1.54	0.12	1.57	0.10	1.50	0.13	2.15	0.19
Fe_2O_3 (%)	7.48	0.63	12.81	1.03	8.19	0.78	10.30	0.91	10.48	2.09
MnO (%)	0.133	0.010	0.090	0.019	0.059	0.021	0.139	0.020	0.072	0.014
V	121	12	168	13	104	13	117	15	113	24
Cr	142	12	236	13	145	10	181	13	176	13
Ni	70	7	141	11	59	7	104	7	83	18
Sr	314	52	286	47	94	41	83	9	129	23
Y	40.6	2.2	42.5	5.9	32.0	3.9	66.3	6.1	52.1	11.7
Ba	389	70	639	203	145	28	233	25	149	36
La	41.9	2.9	38.6	2.5	29.9	4.1	55.8	5.1	59.5	5.7
Ce	87	8	66	8	66	8	84	7	110	9
Nd	39	4	38	5	30	4	55	4	55	9
Sm	8.1	0.8	8.2	1.4	6.3	0.8	11.8	0.9	11.4	2.3
Eu	1.88	0.18	2.13	0.37	1.46	0.19	2.86	0.17	2.90	0.61
Tb	1.2	0.1	1.2	0.2	1.0	0.1	1.8	0.1	1.6	0.3
Yb	3.6	0.3	3.5	0.3	3.1	0.3	4.7	0.4	4.3	0.7
Lu	0.54	0.05	0.50	0.04	0.51	0.04	0.76	0.06	0.69	0.10
Th	9.3	1.0	7.1	0.8	8.9	1.1	9.5	1.2	10.7	1.7
U	2.5	0.6	3.2	0.2	2.5	0.2	3.5	0.3	2.5	0.4

Table 1. Levantine Wares and Acre's productions: mean composition (m) and standard deviation (σ) of the main groups of chemical composition, ppm except (%). n= number of samples in the groups.

separate group in the dendrogram (Fig. 7, Table 1: group B). It is isolated in the first place by its comparatively higher contents in alkalines and alkaline-earths. Petrographic analysis of Acre bowls indicate an assemblage of well sorted quartz, decomposed carbonates, accessory minerals feldspars, epidote, hornblende and chert, which points to the coastal Pleistocene formations of Israel occuring around Acre (Porat in Waksman 1999). The available archaeological and archaeometric evidence, i.e. the presence of wasters of Acre bowls in Acre, the distribution of the finds of these bowls apparently nearly restricted to Acre, the distinctive chemical features of the group and the inclusion of most of the wasters in it, the coastal mineralogical assemblage, give a coherent picture and designate group B as a reference group for Acre's production.

The other groups of ceramics are characterized by iron-rich pastes poor in alkalines. Among them, chemical as well as petrographic analysis singles out another group which closely corresponds to slip-painted wares (Fig. 7, Table 1: group P). These ceramics have a higher calcium content, as well as higher concentrations in iron and in transition elements of the iron series (V, Cr, Ni). Samples of group P are also distinguished by petrography, as they are the only ones which include iron oolithes, red glassy fragments and probably (very degraded) basalt fragments (Porat in Waksman 1999). That it appears as a separate group does not necessarily mean that it corresponds to a workshop specialized in the slip-painting technique of decoration. Rather, as suggested by Picon, only these wares out of a more diversified production may have reached the market of Acre.

The reserved-slip bowls also appear as a separate group (Fig. 7, Table 1: group R), though less clearly individualized. It shows higher aluminium and titanium concentrations and variable rare-earths content. The remaining samples consist in sgraffito bowls and glazed cooking wares. The analyses indicate that similar low to medium calcareous raw materials were used to manufacture sgraffito wares and cooking pots (Fig. 7, Table 1: group S+C1), the cooking wares corresponding to the low-calcareous end of the group. Still, unlike the case of Beirut as seen in a preliminary study (Waksman in François, this volume), there is not such a clear-cut separation between clays used to produce cooking wares, which have to resist thermal stress and for which low calcareous clays are more adequate (Picon 1995), and clays used for table wares, that do not have to meet such technical requirement. Another small group of cooking wares is isolated in the dendrogram (Fig. 7, Table 1: group C2) mainly because of its higher rare-earths content. It is noticeable that within the two groups containing cooking wares, both thick-walled cooking pots, more typical of the end of the 12th and of the 13th century, and thin-walled cooking pots, typical of the Earlier Islamic period and of the 12th century, are represented (see part I for descriptions). The typological distinction is apparently not reflected by chemical analysis, though our restricted sampling in thin-walled cooking pots calls for caution as to any conclusion at this phase of investigation.

Petrographic analysis identifies a common basis in the mineralogical content of samples of Levantine wares: medium to poorly sorted quartz mainly, few if any large carbonates grains, few stable heavy minerals epidote, zircon and tourmaline, occasional shale fragments and rare chert grains. These features correspond to a mature siliclastic formation which would include sandstone, shale, and perhaps siltstone. Such a geological context is probably related to the Lower Cretaceous formations which crop out in large occurences on the slopes of the mount Hermon in Northern Israel, across Lebanon and in Trans-Jordan. It does not occur in the close vicinity of Acre and the wares are therefore considered as imported into Acre (Porat in Waksman 1999).

The Lower Cretaceous formations actually partly parallel the area of distribution of the Levantine Wares, and we can not point at the moment to a more precise location. However, the fact that Beirut, where several kilns of various periods including the Frankish period were recently discovered (Arnaud 1996; François, this volume), is located very close to Lower Cretaceous outcrops make out of Beirut a possible source for at least part of these wares. This hypothesis is currently under study in the "Laboratoire de Céramologie" in Lyon (Waksman, forthcoming c).

In a wider perspective, further information on the production of Levantine Wares, the corresponding workshops, their organization and its changes over time may benefit from further laboratory work, but would certainly gain in the first place from a deeper study of identified workshops. The case of Beirut shows, once more, that a single site could produce a range of ceramic types, with a variety of raw materials (François, this volume). The fact that several groups of compositions appear within the Levantine Wares imported in Acre (groups S+C1, C2, R of cooking wares, sgraffito and reserved-slip bowls) does not thus necessarily point to several distinct production sites. Some insight into the characteristics of available clays in the region is also presently lacking. Both Beirut's productions and Acre's imports of Levantine Wares share common features in their low alkaline and high iron contents. Whether these are regional chemical features, that could correspond to a number of workshops within the Frankish states, or whether they could point to a more specific location would need to be investigated.

Another aspect which may be of interest concerns the technical properties of the Levantine cooking wares. One may wonder whether their iron-rich paste make them especially suitable for a culinar use and could justify their trade on a rather large scale.

Imports related to the Byzantine type "Zeuxippus Ware"

Our ability to attribute imported samples to their origin is still very limited in the present knowledge of Medieval production sites in the Eastern Mediterranean area. Among the identified workshops, at least three are proved or suspected to have manufactured wares of the "Zeuxippus Ware Family": Pergamon in Asia Minor (Waksman 1997: series B), Lemba in Cyprus (Megaw 1983: 263) and Venice in Italy (Berti 1997: 87-89).

Since first distinguished by Megaw (Megaw 1968), "Zeuxippus Ware" has been extensively referred to in publications and could be considered as one of the best known types of Byzantine ceramics. Its occurrence has been reported in a wide area extending from Italy and Southern France to the Levant and from the Black Sea to Egypt (see e.g. François 1997). However, as more and more material is published, it appeared that this ware does not correspond to a unique production and that it has generated imitations and derivatives (e.g. Armstrong 1992; Spieser 1996: 45-46, 51; Stern 1997: 54-56) as a result of its influence on the decorative "repertoire" of the 13th century (Spieser 1991: 257-258) – thus the extension of the "type" to the concept of "family" (Megaw 1989). Besides, Boas interestingly pointed out the existence of two compositional groups of high quality "Zeuxippus Ware" indistinguishable by typology, although his tentative conclusions on provenances still have to be considered as hypotheses (Boas 1991: 198-200; 1994: 118). The distinction between one or several "prototypes" and "derived" productions became quite desirable in order to avoid confusion and can be achieved with the help of analyses. A comprehensive analytical and typological study of "Zeuxippus Ware" found in a number of sites of the Mediterranean area and the Black Sea has recently been undertaken by Waksman and François and will reconsider the whole question of production and diffusion of this ware. The present contribution initiated and constituted a first step of this larger project.

Out of the 43 samples analyzed in this study (Fig. 6), eleven can be typologically attributed to "Zeuxippus Ware" - class II, as defined by Megaw. The other samples were divided into three typological groups, two called by E.J. Stern "Zeuxippus influenced ware" and one related to the Italian ware "Spirale-Cerchio" (cf. part I). The four typological categories are clustered by the classification based on chemical compositions into three well-differentiated groups, a few samples remaining unassigned (Fig. 8, Table 2). They can be distinguished chemically from Acre's productions and from Levantine Wares, of the latter readily by their much higher contents in alkalines and lower concentrations in iron. Petrographic analysis confirms their imported status, as the metamorphic elements present in their paste exclude a regional provenance. All the samples examined by petrography except one show similar features, such fine pasted ceramics being more difficult to characterize by petrography. The sherds have a finely micaceous matrix with varying amounts of silty quartz. They are lightly tempered with well sorted subrounded quartz, micas, metamorphic rock fragments, decomposed carbonate grains, feldspar, oxyhornblende, mudballs and microquartz. These features point to a metamorphic terrain with plutonic rocks such as granite nearby. The clays used by the potters are probably derived from soils or river deposits (Porat in Waksman 1999).

Except for one outlier (Fig. 8, sample ZW1), chemical analysis confirms that the samples of "Zeuxippus Ware" examined correspond to one well defined group (Fig. 8, Table 2: group 1). Its homogeneity is noticeable, with coefficients of variations well below 10% for most elements. An interesting feature of this group is its distinctive slip. All the sherds belonging to it have a slip made of pure clay, whereas the slip of all the other samples considered but the one outlier mentioned above is a more or less quartz-rich material. The information available on slips is still very scarce, and this noticeable particularity certainly calls for further observation and analysis before any conclusion as to its discriminative power can be drawn.

From its finer fabric, group 1 is assumed to be a potential prototype for the other ceramics of the "Zeuxippus Ware Family". This hypothesis is somewhat supported by the compositional similarity of group 1 with one sample unearthed in the distant site of Pergamon, considered to be a "genuine" "Zeuxippus Ware" and previously analyzed by PIXE and INAA (Waksman 1997: fig. 5; 1995: sample M107, annex 4). Such a comparison between one sherd and a small compositional group needs to be reconsidered in the scope of a larger sampling. Also calling for further research is the question of the unicity of the "prototype" of "Zeuxippus Ware" raised by the presence of one outlier in our sampling, and already pointed out by Boas (Boas 1994: 118) and by Berti (Berti 1997: 92-93). The number of production centers as deduced from the number of compositional groups that could be distinguished within an extensive sampling, and their associated typology and area of diffusion, are among the scopes of the project undertaken by Waksman and François. As to the location of the workshop(s), there are little clues so far (see Hatcher, this volume). "Zeuxippus Ware" was first thought to be Constantinopolitan, due to the large amounts of ceramics of this type discovered in the urban excavations in Istanbul. However, no field discovery has come to confirm this hypothesis. Megaw and Jones (Megaw 1983: 263) suggested an Aegean origin on the basis of the elemental similarity of two sherds from Paphos and of one sherd of Aegean style. But this proposition, although supported by Mannoni's petrographic analysis of examples found in Italy (Berti 1997: 92-93), remains at the present step an hypothesis

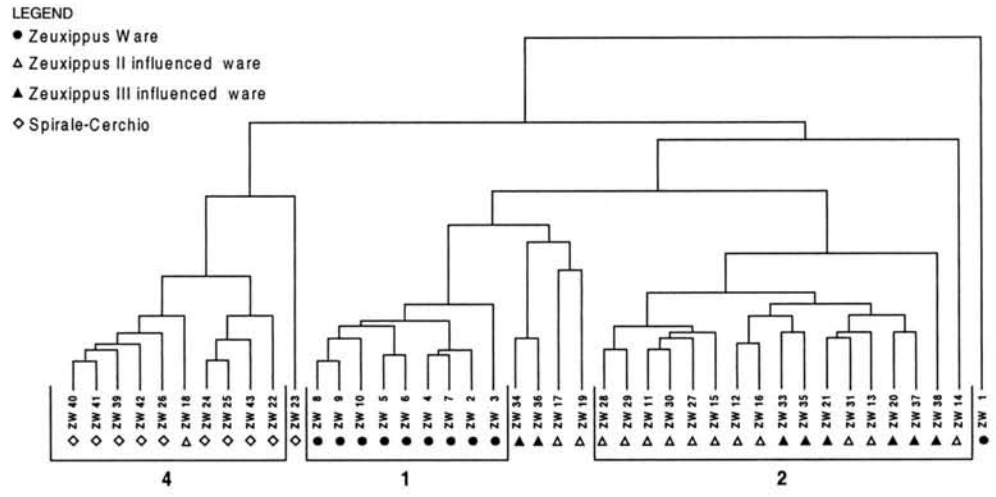


Fig. 8. Classification based on chemical composition of imported ceramics related to the "Zeuxippus Ware Family". Dendrogram obtained by hierarchical clustering analysis on the normalized concentrations of 18 elements. Typological categories are represented by symbols (cf. legend). The main compositional groups are underlined (drawing M. Vichy, Laboratoire de Céramologie Lyon).

	group 1		group 2		group 4	
	m	σ	m	σ	m	σ
n	9		17		9	
Na_2O (%)	1.04	0.07	0.56	0.12	1.64	0.20
MgO (%)	3.51	0.25	4.17	0.39	2.24	0.30
Al_2O_3 (%)	14.89	0.62	19.13	0.95	18.82	1.51
K_2O (%)	2.48	0.17	3.30	0.26	4.26	0.34
CaO (%)	8.33	1.15	11.48	1.13	1.70	0.91
TiO_2 (%)	0.83	0.02	0.71	0.03	0.77	0.02
Fe_2O_3 (%)	7.09	0.28	8.01	0.46	5.66	0.40
MnO (%)	0.156	0.012	0.131	0.021	0.051	0.005
V	129	12	130	11	101	11
Cr	245	13	303	33	106	11
Ni	152	8	224	33	48	4
Sr	297	50	295	39	112	16
Y	29.4	0.8	37.6	1.8	39.6	2.4
Ba	439	31	436	32	690	99
La	32.4	1.1	44.1	2.7	50.1	3.2
Ce	61	4	76	5	96	5
Nd	29	1	36	2	43	3
Sm	5.7	0.3	7.2	0.5	8.7	0.5
Eu	1.30	0.06	1.54	0.11	1.66	0.13
Tb	0.8	0.0	1.0	0.1	1.2	0.1
Yb	2.8	0.1	3.3	0.2	3.6	0.2
Lu	0.39	0.03	0.47	0.03	0.53	0.02
Th	10.6	0.3	14.4	1.6	16.8	2.4
U	2.8	0.1	3.9	0.7	3.2	0.2

Table 2. Imported ceramics related to the "Zeuxippus Ware Family": mean composition (m) and standard deviation (σ) of the main groups of chemical composition, ppm except (%).
n: number of samples.

to be investigated. Boas proposed a Cypriot origin for one of his groups of "Zeuxippus Ware" on the basis of its elemental similarity with typical 13th-century Cypriot slip-painted and sgraffito wares (Boas 1991: 198-200; 1994: 118). Such a conclusion, based on a group of three samples of "Zeuxippus Ware", certainly calls for further research and steadier proofs.

Most of the samples of the two groups of "Zeuxippus influenced ware" related typologically to 13th-century Cypriot sgraffito ware belong to the same compositional group (Fig. 8, Table 2: group 2). Group 2 corresponds to rather calcareous ceramics (*c.* 12% CaO) bearing the highest concentrations in magnesium, iron, chromium and nickel of the sampling of imported Byzantine wares considered. One sample which appears as an outlier of group 2 in the dendrogram (Fig. 8, sample ZW14) is still included in the group, as it only differs by a much higher barium content probably due to contamination of the sherd during burial (Picon 1987).

Except for one sample bearing a key motive on the interior of the base (Stern 1997: 55, fig. 12.94), the compositions of samples of group 2 are very different from the ones of ceramics from the Cypriot kilns of Lemba. Although they are similar typologically to Cypriot 13th-century sgraffito ware (cf. part I), it is unlikely that they correspond to productions from workshops of this area around Paphos. One may wonder if they were manufactured in another Cypriot production center, appearing as a main provider of glazed bowls in Acre given the abundance of imports of this category (Fig. 4). We unfortunately lack chemical references for any other 13th-century Cypriot workshop at present. Further clues and comparisons may have to await the forthcoming publication of the results of Armstrong and Hatcher's study (Armstrong 1997b). In this perspective, a batch of 13 samples and standards also analyzed by Hatcher was included in our sampling and inter-calibration between laboratories is in progress.

The last category of wares examined is typologically related to the "Spirale-Cerchio". It corresponds chemically to a clearly separated group (Fig. 8, Table 2: group 4), with a distinctive feature in its low calcium (1-2% CaO) and strontium content, whereas barium remains at a relatively high level. Its contents in chromium and nickel are also the lowest of the sampling of "Zeuxippus Ware Family".

The relevant typological parallels are Venetian productions, which were characterized by Lazzarini and Calogero (Calogero 1983: 68; Lazzarini 1989: 582) and more recently by Mignucci (Mignucci, forthcoming). The compositions of group 4 show a close correspondance with the reference group established by Mignucci, which includes Spirale-Cerchio, San Bartolo Ware, Roulette Ware, other glazed wares and kiln material (Mignucci, forthcoming). Samples of group 4 found in Acre are most likely to be Venetian imports.

CONCLUSION

This study enabled the constitution of a new analytical reference group corresponding to a production center of ceramics in Acre at the Crusader period, at a time when its harbour was of particular importance in the Eastern Mediterranean area. The picture that emerges from our sampling is that only the Acre bowls, simple unglazed bowls that do not seem to have been diffused much further than the close surroundings of Acre, proved to have been locally manufactured. Even though other categories of vessels, which present to the naked eye the same clay as the Acre bowls (cf. part I), were not considered in this study and may prove to be local as well, it is seen that some of the most typical Levantine wares of the Crusader period were not manufactured in Acre.

These include sgraffito, slip-painted and reserved-slip bowls and glazed cooking pots, which are found in the Levant, in Cyprus and in minute quantities in the Western Mediterranean area. Among them, the slip-painted ware clearly differs from the other categories by its elemental and petrographic features, pointing to a specific production or to the specific export of this ware to Acre, maybe from a site located further away. The reserved-slip ware may also correspond to a separate production, whereas sgraffito bowls and most of the cooking pots share the same analytical characteristics. The latter fact attests the use of similar clays to manufacture cooking wares and table wares. The locations of the manufacturing sites of the Levantine Wares remain a subject for further research. Cooking pots, sgraffito and reserved-slip wares are related by petrography to Lower Cretaceous formations which have large outcrops in Lebanon. Beirut is being investigated as a possible provenance, as Medieval kilns were found in this city which is located very close to such geological formations.

The present study also brought information about some categories of ceramics imported in Acre which are related to the Byzantine type "Zeuxippus Ware". Three compositional groups were defined and characterized. The first group corresponds to a potential prototype for the other categories and presents a distinctive feature in its slip made of pure clay. The second shows typological parallels with Cypriot 13th-century sgraffito but is chemically unlike the productions of Lemba. The third most probably corresponds to Venetian imports.

(by S. Yona Waksman)

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