

A TWELFTH-CENTURY OIL PRESS COMPLEX AT THE CRUSADER TOWN OF ARSUR (APOLLONIA-ARSUF) AND THE OLIVE OIL INDUSTRY IN THE LATIN KINGDOM OF JERUSALEM



Etan Ayalon

Oren Tal

Elisabeth Yehuda

ABSTRACT

This article documents an oil press discovered in the southern part of the Crusader town of Arsur (Area E), dating to the twelfth century CE. To date, no olive press from the Crusader period, excavated in systematic-scientific excavations, has been published in full. The article also discusses the olive oil industry in the Latin Kingdom of Jerusalem based on the available archaeological findings published thus far. It includes our current understanding of the development of olive oil production technology in the Holy Land and the role of the Crusader interlude as bridging the period between large-scaled and sophisticated Byzantine oil presses with those of late Ottoman (pre-modern) industry, which were smaller and simpler.

Apollonia-Arsuf, located on the Mediterranean coast of Israel, some 17 km north of Jaffa (ancient Joppa, south of Tel Aviv) and 34 km south of Caesarea, has been excavated continuously during the last 35 years.¹ Once a modest coastal settlement, Apollonia-Arsuf became the urban center of the southern Sharon Plain as early as

the Persian period (late sixth century BCE) through the Crusader period (until the mid-thirteenth century CE).

The history of the site's occupation during the Crusader period is relatively well covered in the historical sources (Roll 1999: 11–18). The town was conquered by Baldwin I of Jerusalem and his army in 1101 CE and incorporated in the royal demesne. Several decades later, Arsur became the seat of an independent feudal seignury that extended over the southern Sharon Plain. Its first known lord was Johannes de Arsur, a close ally and supporter of King Amaury I (1163–1173 CE). As an important Frankish settlement inhabited by Crusaders, colonists, and pilgrims, it possessed its own burgess court (Pringle 1997: 3–4). In 1187 CE, Arsur was briefly occupied by Saladin's forces, but was re-conquered by the Crusaders during the Third Crusade after the Battle of Arsuf, in which Richard I (“the Lionhearted”), king of England, personally directed the victory over Saladin on September 7, 1191 CE. In 1207 CE, John of Ibelin, the “Old” Lord of Beirut, married Melisende of Arsur and became lord of Arsur. John II of Arsur, one of his younger sons, inherited the seignury in 1236 CE. He rebuilt the town walls and constructed a concentric castle in 1241 CE in its northwestern part.

From 1260 CE onwards, as danger increased from the expanding Mamluk sultanate, it became crucial for a strong and well-organized military order to garrison Arsur. Hence, in 1261 CE, the rights over the castle, the town, and the entire seignury of Arsur

(*castellum, civitatem et dominium de Arsur*) were leased to the Hospitallers by John II's son, Balian, for 4,000 gold bezants a year (Delaville le Roulx 1883: 194–95, no. 88). This act effectively brought the actual lordship of Arsur to an end, although later heirs of the Ibelins continued to bear the formal title of lord or lady of Arsur until the late fourteenth century. The Hospitallers were granted the profits of justice in Arsur in 1263 CE, and according to Muslim sources, in that same year they apparently started to build up a stronghold in the town (Riley-Smith 2012: 208). This probably meant an eastern enlargement of the walled town, as confirmed by surveys and excavations at the site. The Mamluk sultan, Baybars (1260–1277 CE), considered this act a violation of the treaty that he had just concluded with Crusader leaders.

According to historical sources, on March 21, 1265, a large and well-equipped Muslim army under the personal command of Baybars laid siege to Arsur. From the Crusaders' point of view, Arsur was relatively well prepared. Its town and castle were strongly fortified, well provisioned, and defended. On April 26, after 35 days of the siege, a concerted attack was carried out and the town was taken by storm. The surviving defenders took refuge in the castle and continued to fight. However, after three more days of fierce battles, Muslim warriors took control of part of the castle's fortifications and were able to raise the banners of Islam over the walls. The Hospitallers, having lost up to 1,000 warriors, including 90 knights, offered surrender on the condition that the survivors would be free to leave. Baybars at first agreed, but then reneged on his promise and the survivors were taken into slavery. Moreover, Baybars forced the Christian prisoners to participate in the systematic demolition of their own stronghold (see Amitai 2005 for the historical sources; and Tal and Roll 2011 for the archaeological evidence).² Arsur was subsequently razed and left in ruins, never to be properly inhabited again. This final destruction is largely attested by thick conflagration layers and ruins that were uncovered, particularly in the excavated areas of the castle (Tal and Roll 2011: [43]–[46]).

The oil press discussed in this article was discovered in the southern part of the town (Area E) (Fig. 1). In this area, a series of rooms, abutting the town's southern fortification wall, were discovered, filled with soil

and stones to the tops of their truncated walls (Fig. 2). As a means of preparation against the Mamluk siege (1265 CE), a solid mortar flooring about 6 cm thick was laid above this fill, covering the entire area and abutting the wall. This phenomenon was observed in three contiguous excavation squares from the town wall and northward. The planned, intentional abandonment left the earlier levels of Crusader occupation sealed (with many of their findings *in situ*). Since the area yielded no assemblages dating exclusively or mainly to the thirteenth century, the abandonment and blocking of the rooms could have happened earlier, during the end of the twelfth century. However, given the evidence of thirteenth-century occupation in the adjacent areas (Area P, farther to the east, and Area T, farther to the north), it is likely that the intentional abandonment of the rooms in this area hardly left finds that can be dated to the latest phase of Crusader occupation. In any event, the urban character of the southern area in a strip at least 15 m wide, from the town wall inward, changed totally. No longer were dwellings and workshops accessed through alleyways in this area, their place was taken by a raised, solid level, open area up to the wall, which had been made much more solid and thicker.

In two of the excavated rooms along the town's southern fortification wall, remains that belong to an oil press complex were discovered. These remains will be described below, together with the installations and some of the finds found therein that provide a relatively firm dating. A reconstruction of the oil press mode of operation will also be suggested, along with a survey of the known oil presses of the Crusader period in the country and the technological changes they display, and finally a proposal of how the Arsur press helps to reconstruct the history of olive oil technology from the Crusader to the late (pre-modern) Ottoman period.

Although there might be parts that are missing in this installation, the importance of this complex lies in the fact that to date no olive press from the Crusader period, excavated in systematic-scientific excavations, has been published in full. In general, the number of oil presses that can be definitely attributed to this period is very little in relation to the number of settlements in the Latin Kingdom of Jerusalem (see below).

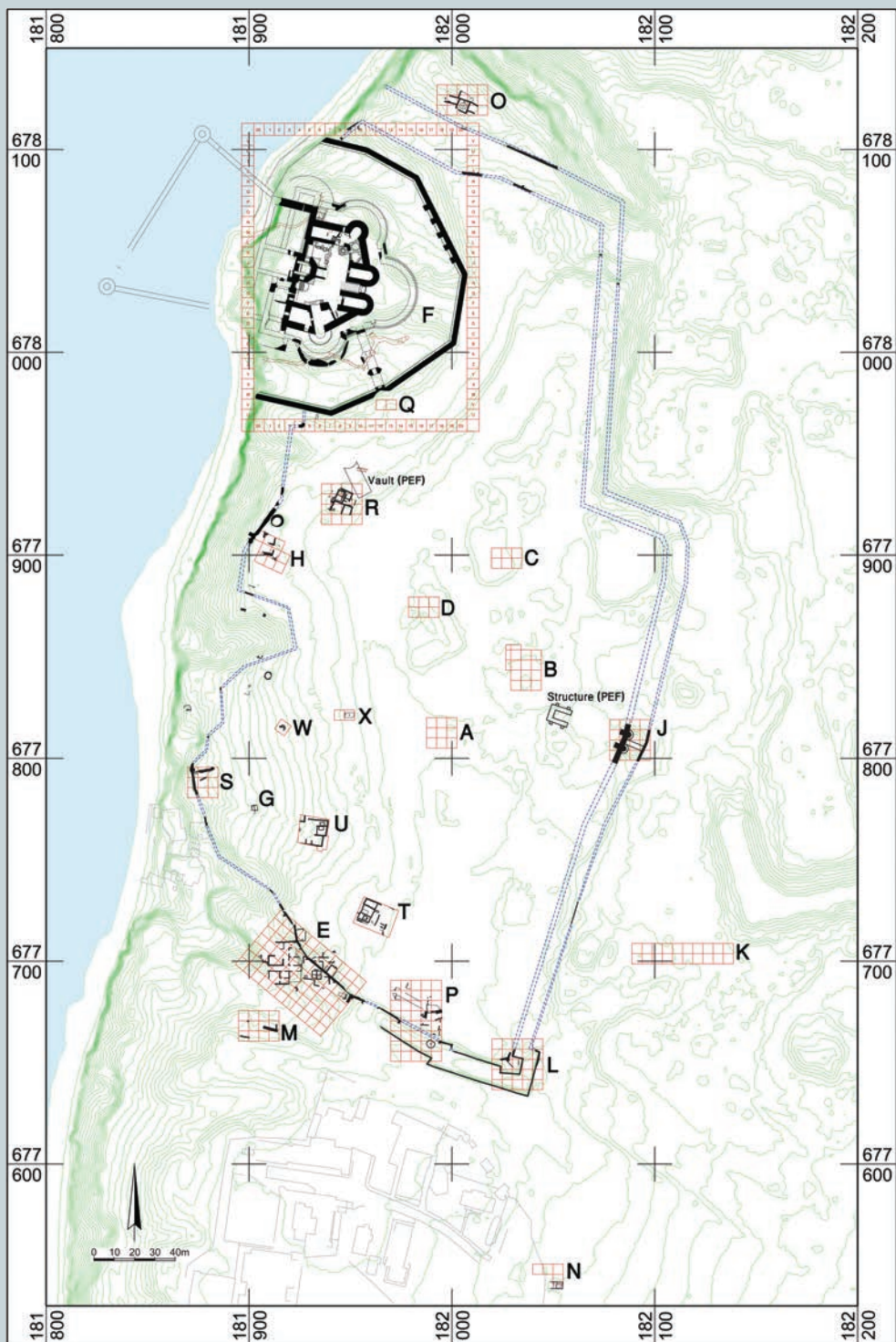


FIG. 1

A site plan of Apollonia-Arsuf with excavated areas indicated. Note that the oil press was discovered in Area E. (Survey and drawing by S. Pirsky.)



FIG. 2

An aerial view of Area E (top left), Area T (bottom left), and Area U (center right) as seen from the northeast in the summer of 2013. (Photo by Hornet Ltd.)

The Architecture of the Oil Press Complex

Room 1372

The walls of the room in which the discussed oil press complex was found (L1372) are abutting the town's southern fortification wall and are designed in an off-perpendicular alignment to it. Therefore, the room's northern wall (W4060) is not fully parallel to the fortification wall, thus creating a room with a trapezoid-like contour (Fig. 3).³ The room measures 4.1 m long (on the west), 4.7 m long (on the east), and 3.6 m wide. The fortification wall in the room area measures 1.1 m thick, and is preserved to some 2.3 m high from the room's floor. The town wall is built of relatively small ashlar that are covered in the room with white plaster on its lower courses. While all the finds found on the room's floor

(F1372; 30.67 m above sea level) date to the Crusader period, the room was probably built during the Early Islamic period and continued to be used in Crusader times, given the level of the foundations of its walls. Thus, W4103/W1373 on the west (0.4 m thick, 1.2 m high) shows a lower (Early Islamic) plain construction and an upper (Crusader) plastered construction. The upper construction preserved an opening (1 m wide) that leads to a small room (L1358) that probably served as the oil press complex storage facility (Figs. 3–4 and see below). W1377 on the east is poorly constructed; only its western face was preserved, hence its total width is unknown. W4060 on the north (0.4 m thick and 1 m high) was plastered and consisted of an opening (1 m wide). The base of a staircase was found in the courtyard to its north, attached to W4060's northern facade and oriented to east, probably providing access to a second story whose floor was

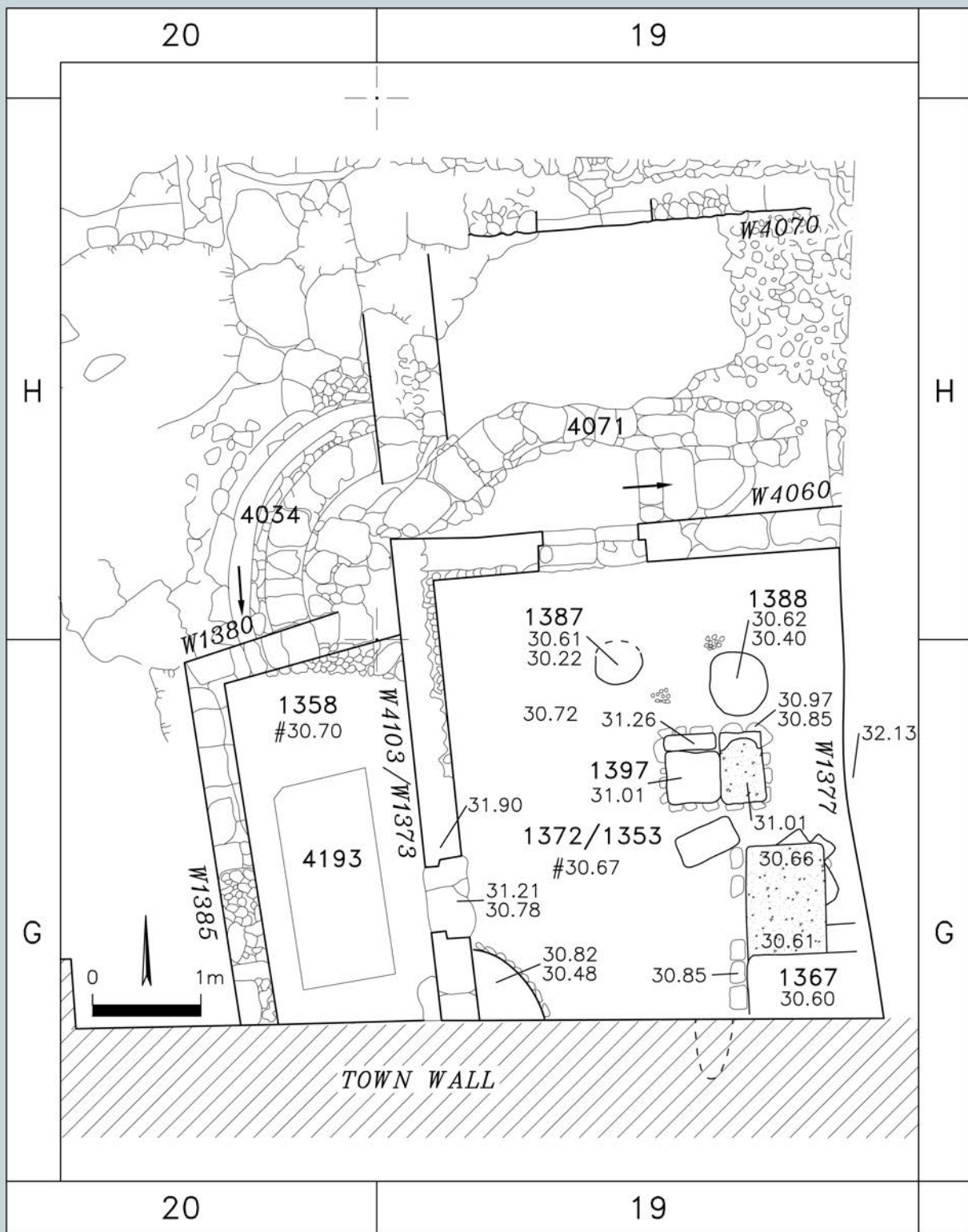


FIG. 3

A plan of the oil press complex found in L1372 of Area E. (Drawing by A. Brauner.)



FIG. 4

Room 1372/1353, looking east. In the foreground, the intentionally filled opening in W1373; on the right, the town's southern fortification; on the far right corner, L1367; and on the left, segments of stone flooring. (Photo by I. Roll.)

constructed, according to the nature of the debris, of timbers (Yehuda 2010: 125–29). A sewage channel (4071), covered with slab stones, was found embedded in the floor of the courtyard. It extended only to the northern continuation of W4103. It is possible that the courtyard where the staircase and sewage channel were found belonged to the oil press complex, since it preserved the continuation of W1373 and W1377. As a courtyard, it probably served for transporting olives to the oil press and for marketing its output—the oil. North of the courtyard, the southern wall (W4070) of an additional room with an opening was discovered. Once Room 1372 had its intentional filling of soil and stones removed, its floor level yielded pottery, glass, and stone and metal vessels, objects that can generally be dated to the twelfth century, as well as fragments of millstones made of beach-rock and basalt, along with

numerous olive pits and fragments of red-color stucco plaster that may have originated from the second story (a rather rare component in Crusader domestic architecture [Boas 2010: 66]). The room also exhibited several installations that attest to its function as an olive press complex (see below). It is likely that not all the components of the oil press complex were discovered during the excavations, but the evidence at hand allows for a relatively firm interpretation.

Room 1358

Room 1358 adjoins Room 1372 on its western side. It is bordered by W1385 on the west, W1380 on the north, and by W4103/1373 on the east. W1380, which was erected during the Early Islamic period, had only its western part

preserved while the eastern part was breached by two sewage channels leading waste southward through the town wall to outside of the settlement. Two Crusader-period phases were noted: an earlier Phase I with a floor constructed of small fieldstones embedded in a thick layer of mortar. This floor stretched from W1385 to W1373 but did not yield any installations that could have determined the room's function more precisely. During a later Phase II a large pit (L4193; 1.86 x 0.88 m) was dug between walls W1385 and W4103/1373, and was found covered with stones. This pit served most likely for refuse from the surrounding houses. In the same phase, further north, a sewerage channel (4034) was constructed on the surface of F1358 (30.70 m above sea level). This channel (4034) was plastered and open and breached W1380. It turned north of W1380 to the east and ended west of the northern continuation of W4103/1373. The carefully constructed sewerage system, as well as the refuse pit or cesspit and the outlet through the town wall, can be understood as an attempt at town planning.

The Installations of the Oil Press Complex

The oil press complex preserved several installations on its gray mortar floor (F1372; 30.67 m above sea level) (Fig. 3):

- *Installation 1367*: In the room's southeast corner was found a two-component installation: (1) a rectangular surface (1 x 0.7 m) of hard gray plaster laid upon fieldstones that gently slopes to the south; and (2) a pit (1 x 0.55 m and 0.22 m deep) whose sidewalls and floor were built of fieldstones. The pit was found filled with ashy earth, coal and bone fragments, Crusader-period pottery, an intact chisel, and many olive pits. Next to the rectangular surface, an ashlar stone (0.3 x 0.6 x 0.45 m) was found whose function is unclear. Along the lower courses of W1377, a row of fieldstones (0.2 m wide; the top of which is 30.69 m above sea level) was documented. Judging by its level, this "bench" apparently corresponds to an earlier level of occupation.
- A niche (Fig. 5) was carved in the inner face of the fortification wall, 0.43 m above the oil press complex floor (31.1 m above sea level). It measures 0.3 x 0.3 m on its exterior, 0.2 x 0.15 m on its interior, and 0.6 m deep. Around the niche, soot remains are visible on the wall and it is possible that the wooden press beam that was anchored in the niche had been burnt or decayed while still *in situ*.
- *Installation 1397*: In the center of the room, another two-component installation was documented. It was positioned right across the niche some 1.9 m from it: (1) on the west, a rectangular surface (0.55 x 0.55 m) of *kurkar* (fossilized dune sandstone) ashlar (31.01 m above sea level), laid upon a fieldstone foundation and delimited on the north by another smaller, but higher ashlar (31.26 m above sea level); and (2) on the east, a shallow plastered basin (0.5 x 0.4 m; 31.01 m above sea level) that is also laid upon a fieldstone foundation. Its northern part is delimited by an elevated niche whose top is also 31.26 m above sea level.
- *The northern section*: This part of the room revealed segments of flooring made of mortar and small fieldstones, some 0.05 m higher than the floor unearthed on the room's southern section. Two pits some 0.6 m apart filled with reddish earth were also discovered (Fig. 6). In the eastern one (L1388; 0.6 x 0.5 m and at least 0.2 m deep) two worn bronze coins (B12796, B12797) were discovered as well as olive (*Olea europaea*) wood remains. The western one (L1387), which was devoid of finds, measures 0.45 x 0.4 m and is 0.4 m deep.
- *The Oven*: In the room's southwestern corner a quarter-circled oven, whose sidewalls were built of small fieldstones, was discovered (0.7 x 0.6 m and 0.4 m deep). It was found filled with ash, charcoal, and a few olive pits. On top of it, a complete frying pan was exposed (Fig. 9:3). The oven did not disrupt the opening to the room on its west (see, however, Yehuda 2011: [54]–[55], who identifies this installation as a fireplace and reconstructs a chimney. While the primary function of such fireplaces was most likely heating, they were also used for cooking and frying).



FIG. 5
Room 1372/1353, looking south. In the background, the town wall with a niche carved in it;
on the right, an oven; and in the center, Installation 1397. (Photo by I. Roll.)



FIG. 6
Room 1372/1353, looking south. In the foreground, are
the pits (L1387; L1388); and in the background, the
town wall. (Photo by I. Roll.)

The Finds Recovered from the Oil Press Complex

The Pottery

Most of the pottery fragments illustrated in Figures 8–10 came from Loci 1353 and 1358 (floor level of the room to the west) (see Fig. 7).⁴ Baskets 12709 and 12715 were collected right on the surface of Floor 1353, while Baskets 12662, 12666, 12675, and 12695 were located ca. 0.5 m above the floor level, in the ash and stone debris possibly formed during the collapse of a second floor.⁵

- *Imitation of Fatimid Luster Ware* (Fig. 8). Bowls of this type form the largest group recovered from Rooms 1372 and 1358. They include bowls with a simple or small ledge rim, rounded or slanting body, and a thick ring base. Occasionally, the vessels are deep and cup-like with rounded or straight walls, and a simple or slightly outturned rim. The bowls were decorated with motifs mainly assignable to four groups (Mason 1997: fig. 7: FL. 8, FL. 10, FL. 22 and FL. 23). The body was usually decorated with stubby, rounded palmettes (similar to clover leaves and crab-claw palmettes accompanied by discrete tendrils), while the rim

was decorated with wedge motifs (Mason 1997: 218). Vessels of this type were found at Hama (Poulsen 1957: fig. 396), Beth Shean (Avisar and Stern 2005: fig. 13:7, and discussion under p. 35, Type I.3), Caesarea (Mason 1997: fig. 17; Arnon 2008: 318–19, Type 264a), Mi'ilya (Stern 2012a: 66*–67*, fig. 4:15), and in small numbers at Akko (Stern 2012b: 96–97, VI.GL.2). The origin of these vessels is still in question, but it is widely suspected that they derived from Egypt (Avisar and Stern 2005: 36; Arnon 2008: 47–48; Stern 2012a: 69*; 2012b: 97). Preliminary X-ray diffraction analysis of five vessels indicated that they were indeed produced in Egypt (Yossi Gal, pers. comm.). Avisar and Stern dated the bowls imitating late Fatimid Luster Ware from the eleventh century to no later than the end of the twelfth century (2005: 35; see also Stern 2012b: 96). However, Mason states that although the production of luster-painted pottery in Fustat ceased altogether, the production of underglaze-painted pottery continued elsewhere most likely into the thirteenth century (1997: 235). Nevertheless, this family is absent from the assemblages related to the thirteenth-century destruction of Arsuf.

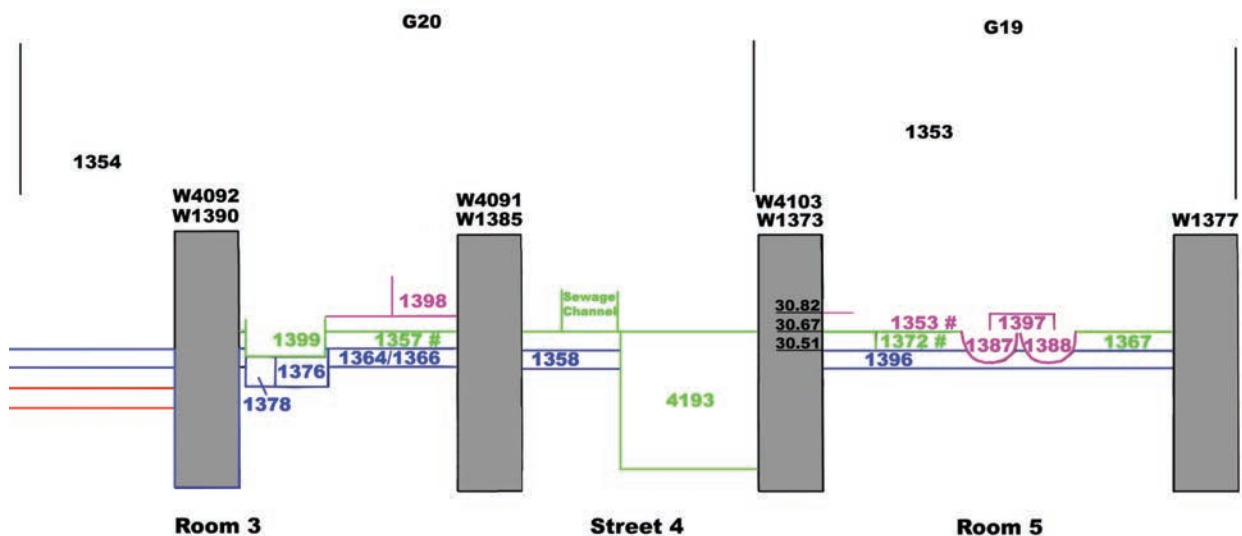


FIG. 7

Section drawing of Rooms 1358 and 1372/1353. (Drawing by L. Yehuda.)

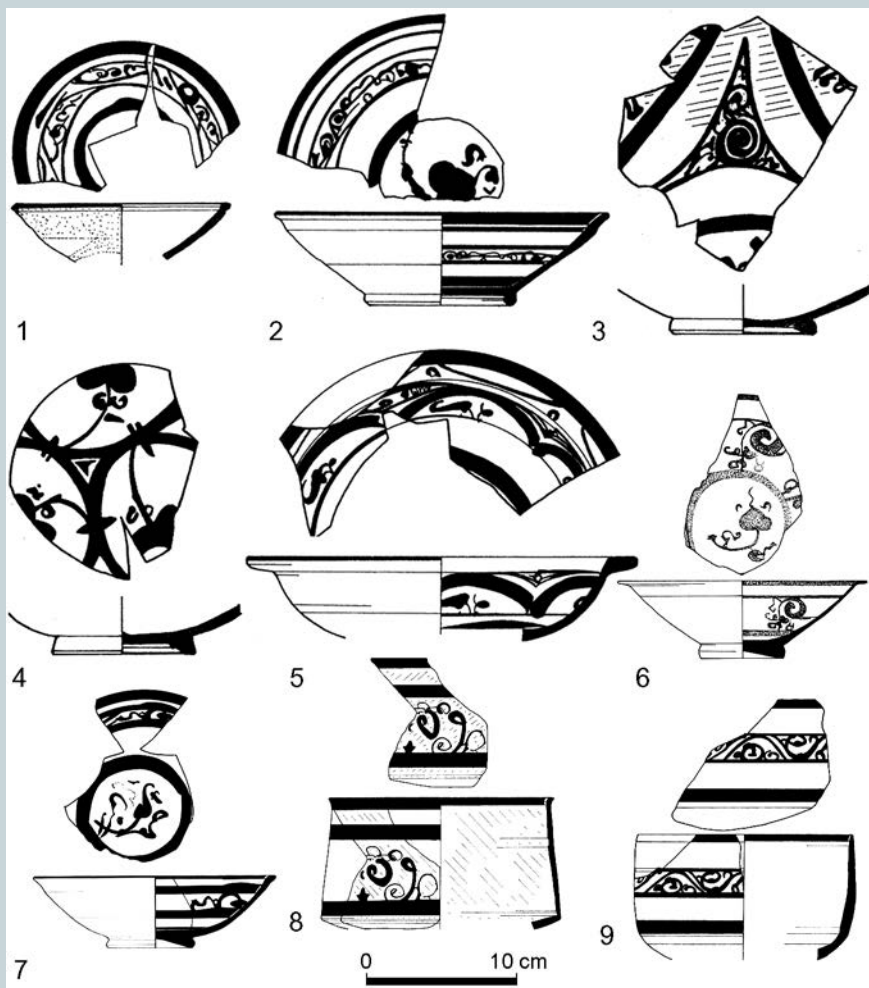


FIG. 8
Imitation of Fatimid Luster Ware pottery
from the oil press complex. (Drawing by
D. Roshal.)

FIGURE 8				
No.	Vessel	Locus / Basket / Inv.	Clay	Surface Treatment
1*	Bowl	1353 / 12675 / 2237		
2*	Bowl	1353 / 12666 / 2176		
3*	Bowl	1353 / 12695 / 2233		
4	Bowl	1353 / 12695 / 2234	Sandy, light pinkish-brown	Black painting on white slip under colorless glaze
5	Bowl	1358 / 12755 + 12734 / 2177	Sandy, light pinkish-brown	Black painting on white slip under colorless glaze
6*	Bowl	1358 / 12696-1 / 2174		
7*	Bowl	1358 / 12667 / 2175		
8*	Bowl	1358 / 12734 / 2173		
9*	Bowl	1358 / 12734 / 2231-1		

- *Bowls with Gritty Glaze* (Fig. 9:1–3). The bowls excavated in Rooms 1372/1353 and 1358 seem to be a transitional type between bowls with double slip and small everted or simple rims, produced during the late eleventh and the first half of the twelfth centuries, and bowls with gritty glaze and more pronounced ledge rims, which started to appear during the second half of the twelfth century (for the double slip bowls, cf. Avissar 1996: 89–90, Type 30; Avissar and Stern 2005: 6–7, Type I.1.1; Arnon 2008: 311–15, Type 261; and Stern and Tatcher 2009: 124–26, fig. 3:17. For the gritty glazed bowls, cf. Avissar and Stern 2005: 8–9, Type I.1.2; Avissar 1996: 92, Type 36; Getzov 2000: 94*–95*, fig. 24:1–10; Arnon 2008: 333–34, Types 271e and 271f; Stern and Tatcher 2009: 126–27, fig. 3:18:1; and Stern 2012a: 66*–68*, fig. 4:9–12). The vessel forms of the bowls from Arsur are clearly similar to the double-slip bowls. They have the same small everted or simply pointed rim with a ridge and a rounded or slightly carinated body. The surface treatment, on the contrary to the above statement, is reminiscent of the later type, the gritty glazed bowls. The bowls' interior shows only a thin wash often carelessly applied with a broad brush and missing along the rim. The glaze is gritty and often of low quality, colored yellow and green with brown and grayish hues. The glaze is often accompanied by a random sgraffito applied in thin strokes. The dating of those bowls, as determined according to the observations made above, is to the mid-twelfth century.
- *Glazed Bowl* (Fig. 9:4). This bowl seems to be another transitional type. The vessel form is clearly reminiscent of the alkaline bowls and monochrome lead-glazed ware of the Early Islamic period, hemispherical with a small ledge rim (Avissar 1996: 82–85, Types 8 and 11), but the clay, which is orange-red and coarse as was commonly used for the production of double-slip and gritty glazed bowls and the surface treatment which shows no slip and preferably yellow-and-green-colored glaze, suggest a production date later than the Early Islamic period, but earlier than second half of the twelfth century when carinated bowls with pronounced ledge rims became more popular.
- *Heavy Bowl* (Fig. 9:5). Bowls of this type were made of brown, relatively fine clay. The rim is thickened and in-turned, and the walls are steep and rounded. Often two vertical loop handles were attached to the rim. They are well known from the Byzantine to the end of the Early Islamic periods (Avissar 1996: 124–26, Type 25; Tal and Taxel 2008: 132, fig. 6.85). They do not seem to be typical of the Crusader period when they were replaced by bowls with straight walls and simple or slightly outturned flattened rims, but they could be addressed as another Fatimid type which continued into the early Crusader period.
- *Cooking-pots* (Fig. 10:1–2). Thin-walled, globular cooking pots with ovoid bottoms and straight rims are widely common in the pottery assemblages of Area E. They were produced during the Fatimid period, from the late tenth century on, and continued into the early Crusader period when they were replaced towards the end of the twelfth century by thick-walled cooking pots with rolled or grooved rims. Fig. 10:1 shows splashes of glaze on the rim and purple glaze on the bottom inside (cf. Avissar and Stern 2005: 92, Type II.2.1.3), while the fragment shown in Fig. 10:2 was unglazed (cf. Avissar 1996: 132–33, Type 5; Yehuda 2007: 146, fig. 10:8; Arnon 2008: 301–2, Type 7520; Stern and Tatcher 2009: 123–24, fig. 3:16:8–10; and Stern 2012a: 66*, 68*, fig. 4:7).
- *Frying Pan* (Fig. 10:3). Many of the frying pans unearthed in Rooms 1372/1353 and 1358 have a fairly flat wide base, straight sloping walls, and a simple pointed or rounded rim. They are fully covered with a thick purple glaze on the interior (Bagatti 1993: fig. 29:16; Avissar 1996: 142, Type 15; see also Avissar and Stern 2005: 96, Type II.2.3.1; and Stern 2012a: 68*, fig. 4:5). Glazed frying pans started to appear already during the ninth century (Tal and Taxel 2008: 137; Avissar and Stern 2005: 96); however, in Area E it seems that fully glazed frying pans with a pronounced triangular rim mark the Fatimid period and the beginning of the twelfth century, while those with a simple or pointed rim seem to appear slightly later, probably around the mid-twelfth century.

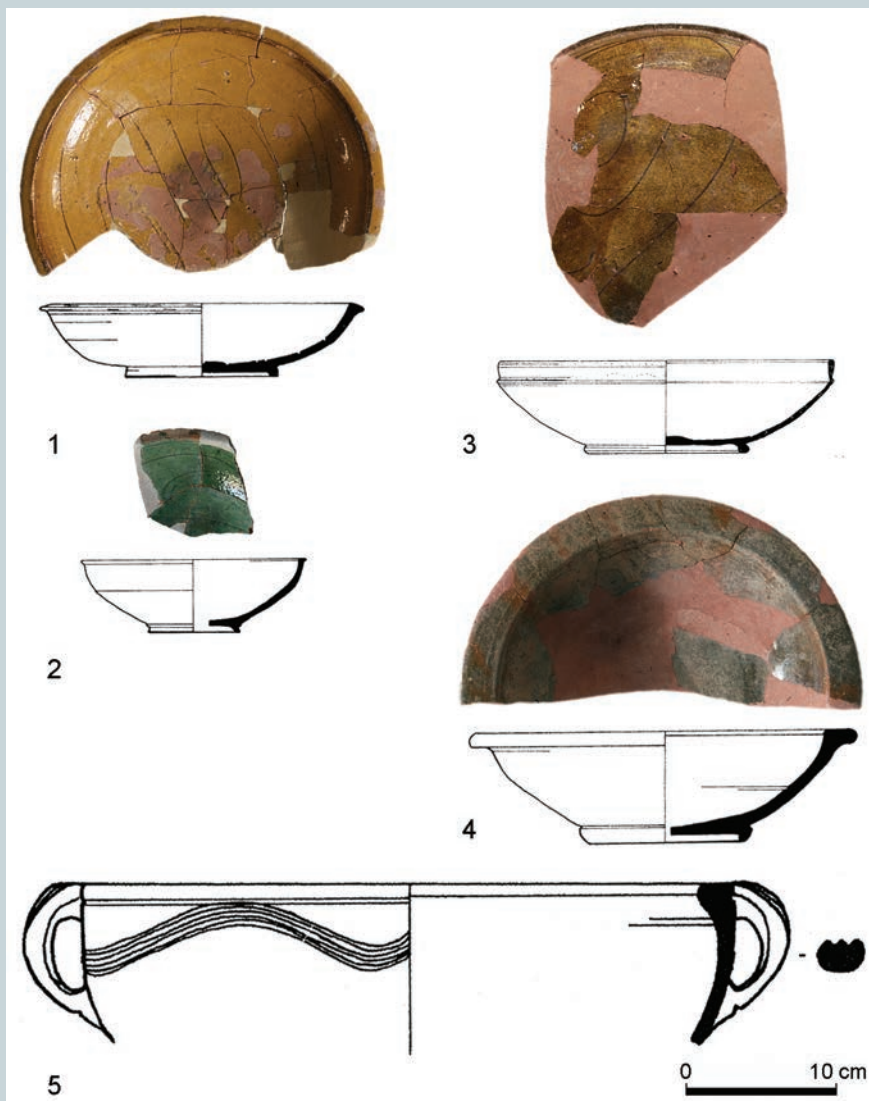


FIG. 9
Bowls from the oil press complex. (Drawing
by D. Roshal; photos by P. Shrigo.)

FIGURE 9				
No.	Vessel	Locus / Basket / Inv.	Clay	Surface Treatment
1	Bowl	1353 / 12662 / 2184	Sandy, brown-red, few small white inclusions	Thin wash outside, inside yellowish slip under yellow glaze, sgraffito
2	Bowl	1353 / 12662 / 2190	Sandy, brown-red, few small white inclusions	Traces of white wash outside, inside carelessly applied wash under yellow glaze, sgraffito
3	Bowl	1353 / 12709 / 2179	Sandy, yellow-red, small white inclusions	Traces of wash outside, inside thin wash under green glaze, spiral sgraffito
4*	Bowl	1353 / 12695 / 2186	Orange-red, few small white inclusions	No slip, yellow/brown-green splashed and mottled glaze
5	Heavy Bowl	1358 / 12696 / 2340	Light orange-brown	Wavy combed design on upper half of body

- *Amphora* (Fig. 10:4). Amphorae of this type with a long narrow neck, pronounced out-folded rim, and vertical handles starting at the middle of the neck were produced from the twelfth century on, and are quite common in Crusader-period sites (cf., e.g., Avissar and Stern 2005: 106, Type II.3.2.4; Stern 2012a: 67*–68*, fig. 4:4), including Arsur where they were found in the castle in a cesspit whose assemblage is assigned to the castle destruction of 1265 CE. Similar amphorae made of buff ware were excavated at Caesarea and dated from the late tenth to the first half of the eleventh century (Arnon 2008: 310–11, Type 854b).
- *Storage Jar* (Fig. 10:5). Storage jars with a straight, relatively long neck, a bag-shaped body with white painting, and a gutter rim are successors of a very similar storage jar which appeared already during the ninth century (cf. Tal and Taxel 2008: 146–47) and continued to be popular during the early Crusader period. However, during the Fatimid period, it seems that the predominant clay used for those storage jars was light or dark brown or grey, while during the Crusader period the clay was commonly orange-red or orange-brown (cf. Avissar and Stern 2005: 100, Type II.3.1.1; Arnon 2008: 305–6, Type 851a; see also Yehuda 2007: 146, fig. 10:15–16).

None of the pottery types recovered appear exclusively during the thirteenth century. Rather the contrary, as many pottery types have their origins in the Fatimid ceramics traditions (notable are the cooking vessels and storage jars that ceased to be produced toward the end of the twelfth century). Bowls imitating luster ware show the distinctive influence of Egyptian-Fatimid ceramics tradition during the eleventh and twelfth centuries, and are not found in considerable numbers in early thirteenth-century assemblages. In the assemblages of Area E (from which a relatively small part is presented in this article), they appear in large numbers comprising in some cases up to 10

percent of certain loci. Gritty glazed bowls with molded or pronounced ledge rims started to appear during the second half of the twelfth century, but the types found in the assemblage clearly form a transition between eleventh and early twelfth-centuries double-slip bowls and late twelfth-century gritty glazed bowls. They are probably typical, at least in Area E, of the mid-twelfth century. Early Byzantine/Aegean imports, such as plain glazed or sgraffito decorated bowls, which started to appear towards the end of the twelfth century, are completely absent in the pottery from Rooms 1372/1353 and 1358. According to the above archaeological considerations, the assemblage that came from Rooms 1372/1353 and 1358 should be dated to the twelfth century, possibly even the mid-twelfth century if one pushes towards a narrower dating based upon the evidence. Be that as it may, we do not exclude a later dating in the twelfth century for the assemblage given the historical evidence we have at hand and the fluid nature of the pottery evidence in terms of its accurate chronological dating (see below).

The Glass and Metal Objects

These are confined to a few artifacts. The first are two glass vessels (Fig. 11:1–2), a jar and a flask/bottle with square walls (both missing their rims). They are minute containers that probably served as containers for pharmaceutical/cosmetic products given their relatively thick walls and small capacity. While the shape of the jar is quite uncommon, the flask is a well-known vessel type, mostly familiar in earlier Abbasid/Fatimid contexts (Lester 2004: 188–90, fig. 7.9:100–5). The cylindrical neck fragment of a glass bottle decorated with applied thick horizontal trails, bordering mock/pseudo inscriptions made of additional applied trails (Fig. 11:3) is also quite uncommon. The elongated handle of a glass pestle is identical to few other such objects recovered at the site (mostly in Byzantine period contexts; Fig. 11:4).⁶ The iron spoon-shaped object (Fig. 11:5) is most probably a chisel, used by beating its top with a hammer, as may be hinted by the solid handle. The lack of socket excludes the possibility that it is a *ḥarḥor*, which was attached to

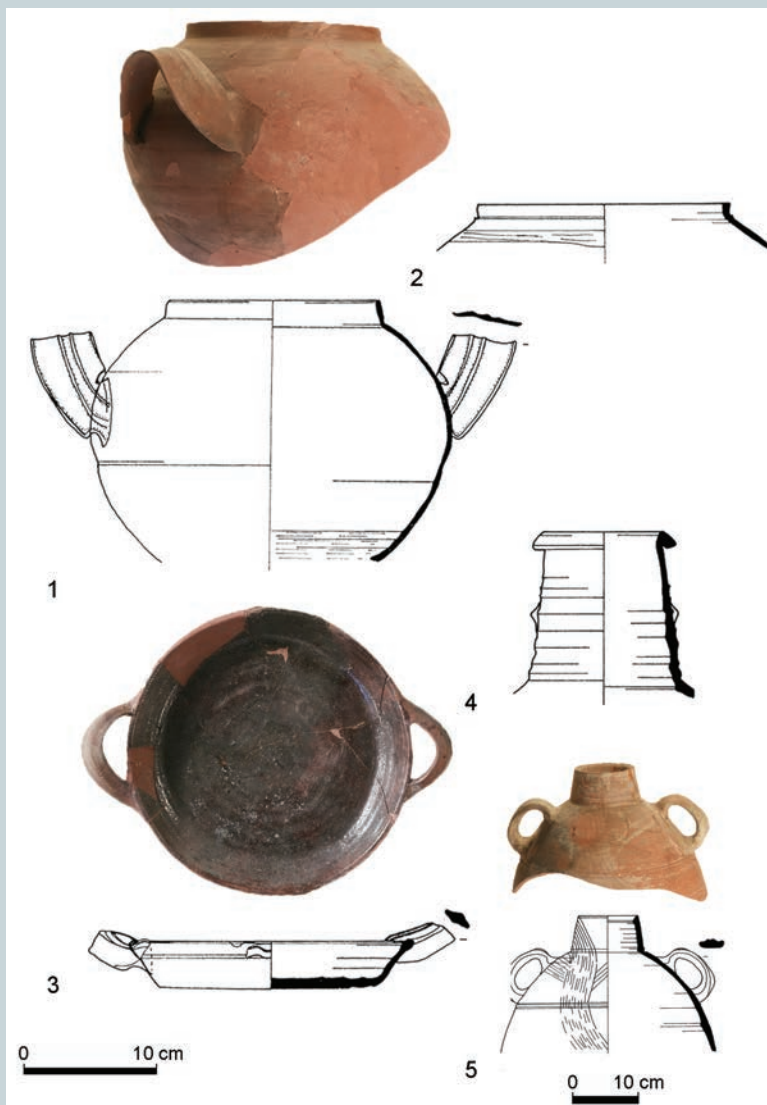


FIG. 10
Miscellaneous pottery from the oil press complex.
(Drawing by D. Roshal; photos by P. Shrago.)

FIGURE 10				
No.	Vessel	Locus / Basket / Inv.	Clay	Surface Treatment
1	Cooking-pot	1358 / 12734 / 2183	Sandy, brick red	Splashes of purple glaze on rim, purple glaze inside on bottom
2	Cooking-pot	1372 / 12768-3 / 2728	Sandy, brick red	
3	Frying Pan	1353 / 12715 / 2180	Sandy, brick red	Fully purple glazed inside
4	Amphora	1353 / 12709 / 2341	Orange-red, some small white inclusions	
5	Storage Jar	1353 / 12675 / 2192	Fine, metallic, orange-brown	Wavy white painting on red-brown surface

an ox goad and used to clean mud from the plowshare while furrowing (Avitsur 1976: 17–22; see also Khamis 1996: 234–35, fig. 18.11:2–3 for Crusader-Mamluk tools with sockets wrongly defined as chisels, but are actually typical goad blades). The possibility that it was used to re-dress the millstones (below) after they wore out (that, according to ethnographic comparisons, had to be carried out after extensive use, especially on the upper stone) is less likely, because of the wide and round shape of the blade. The kohl stick (Fig. 11:6) has numerous equivalents and they are known from various periods and materials, such as bone (Khamis 1996: 225). The decoration on its center probably also served to improve the grip. This piece could have been used together with the mold-blown glass flask discussed above. The intact bronze bell (Fig. 11:7) is relatively uncommon in metal objects assemblages of published Islamic-Crusader sites. It could have been hung on the neck of an animal, used for alerting people when needed, or was simply a decorative item.

The Millstones (Figs. 12–13)

All broken parts of grinding tools found in Rooms 1372/1353 and 1358 belong to the rotary round type of mill (several smaller pieces were also found but not drawn). However, they vary in raw material (beach-rock or basalt) and can be divided into two groups according to their size. The regular rotary hand mill is usually not more than 0.50 m in diameter, as larger stones are more difficult to operate by hand (Frankel 2003: 49). To this type belong Fig. 12:1–3 and Fig. 13:1–2. The rotary mill was introduced in Palestine in the first century CE, probably by Roman legions, but its use spread only in the Byzantine period (Frankel 2003: 46; 2008), and continued without significant change until now. It should be noted that such stones were used not only to mill cereals and legumes, but also to crush olives (see below) and to grind various raw materials such as ores and pigments (Runnels 1990: 147; Minveille Larousse and Bailly-Maitre 2011). The second group consists of large stones of the size known from both animal- and water-powered mills (Fig. 13:3–4). While Millstone 13:3 is a relatively small fragment, Millstone 13:4 is probably an upper stone,

which was reused as a lower one after it was worn out, as shown by the wear on both its faces. This procedure is well known from traditional flourmills in the country. The remains of cement around its edge also point to this conclusion, as the lower stone is normally cemented to the floor and only the upper one rotates. The possible use and origin of these large stones is discussed below (for parallels, see Stern 1994: 230; and Shaked 2000: 69). It is worth noting that a quarry for such large millstones was found underwater in a beach-rock strip near Akko, which was mainly used in the Crusader period (Galili and Sharvit 2001).

The Oil Press Complex Mode of Operation

Production of olive oil requires three phases of work: crushing the olives, pressing the mash and extracting the sap (liquid containing oil and water), and separating the oil. The last phase was usually done in a storage tank or a vessel, where the light oil floated on the surface of the water and was then collected separately (Frankel 2009a). Production of olive oil in ancient Israel shows two main types of installations: small and simple ones for domestic use, which produced small amounts of fine oil for private or familial use; and large sophisticated industrial presses for the commercial production of oil. Since the days of the First Temple until pre-modern times, we find both types of installations used side by side.

It is possible that during the first stage of use there was only a small domestic press in Room 1372/1353—Installation 1367 in its southeastern corner. This would have served to supply small amounts of oil. Only during a later stage was an “industrial” oil press installed. Such a simple device, known in the Mishnah as בודידה (*bodeda*; *badide* in Arabic), served both for crushing and extraction (*m. Šeb.* 8:6).⁷ According to this interpretation, the olives were crushed on the plastered surface in the north of Installation 1367 with the help of a small stone roller. This practice is known from the Iron Age (Eitam 1996: 169) and was in use until the twentieth century. The roller was run back and forth over the olives by hand, with the help of a wooden handle or by feet. In the latter case the operator would have stood on top of the roller

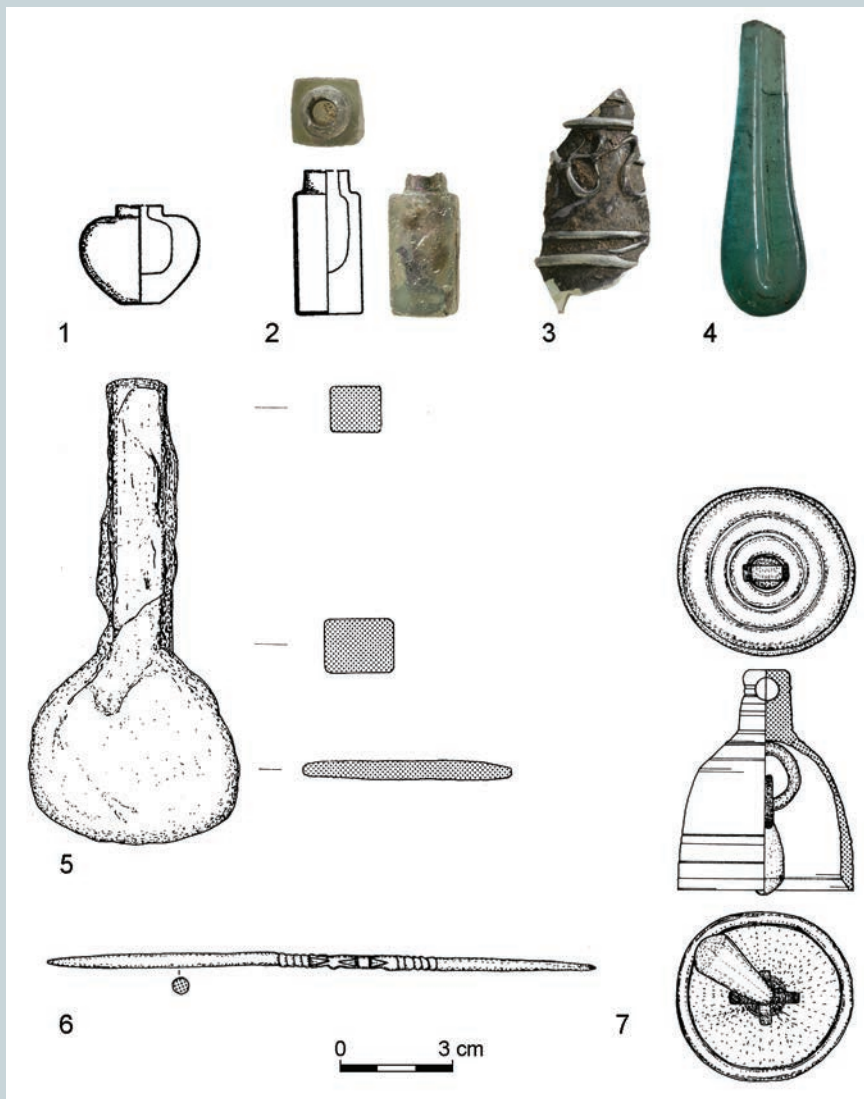


FIG. 11
Glass and metal objects from the oil press
complex. (Drawing by D. Roshal; photos by
P. Shrago.)

FIGURE 11				
No.	Vessel/Object	Locus / Basket / Inv.	Material	Description
1*	Jar	1353 / 12672 / 2167	Glass	Blown (?).
2	Flask	1353 / 12723 / 2168	Glass	Mold-blown. Colorless with yellowish tinge. Remains of thick black, white, and silver weathering. Shiny iridescence. Severely pitted.
3	Bottle (fragment)	1353 / 12764 / 2274	Glass	Blown. Colorless. Remains of thick black, white, and silver weathering.
4	Pestle	1353 / 12764 / 3408	Glass	Casting. Light green. Little silver weathering. Small rounded bubbles. Bottom is slightly flattened and pitted probably due to constant grinding. Broken, 1.8 cm.
5*	Chisel (?)	1353 / 12680 / 2412	Iron	Forge welding. L. 12.4 cm, blade dia. 5.6 cm. Solid handle with square section, flat roundish blade.
6*	Kohl stick	1358 / 12700 / 2425	Bronze	Casting. L. 14.5 cm. Both ends pointed. Center decorated with grooves and rhombus design and is holed.
7*	Bell	1353 / 12697 / 2415	Bronze	Casting. L. 5.8 cm, external dia. 4.7 cm. Tongue still attached to the bell by means of a ring.

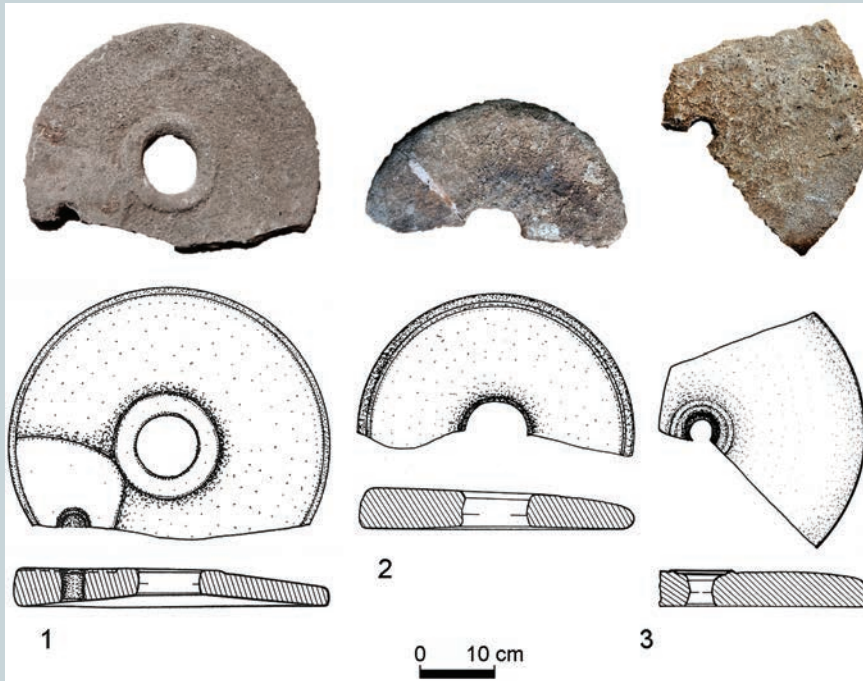


FIG. 12
Millstones from the oil press complex.
(Drawing by D. Roshal; photos by P. Shrago.)

FIGURE 12				
No.	Type	Locus / Basket / Inv	Material	Description
1	Rotary hand mill (upper stone)	1353 / 12754 / 2550	Beach-rock	Dia. 42 cm. Slightly concave. Low collar around the eye on top and 4 radial grooves on bottom. Area around handle socket (dia. 3 cm) is thicker for reinforcement and less dressed. Bottom is worn out.
2	Rotary hand mill (upper stone)	1358 / 12706 / 2544	Beach-rock	Dia. 36 cm. Flat. Uneven thickness. Bottom is worn out.
3	Rotary hand mill (upper stone)	1358 / 12706 / 2543	Beach-rock	Dia. 46 cm. Flat. Bottom is worn out.

and moved it with his/her feet, leaning with his/her hands on a nearby wall. All these methods are known from ethnographic accounts (Fig. 14 = Matson 1980: fig. 3967; Avitsur 1994: 97–99, esp. fig. 95; see also Ayalon 2012: 91). After crushing, the olive mash was collected in baskets and placed on the same surface. A wooden board was then set on top of the baskets and finally a heavy stone was placed on top (following an ethnographic observation in Syria during the early twentieth century, see Avitsur 1994: fig. 99). The liquid, which was squeezed

from the olives, was collected in Pit 1367, and later the oil floating on the water was collected separately. The large ashlar stone, which was found near the installation, could have been used for pressing. It is, therefore, a complete production facility that did not require additional installations.

It is also possible, however, that Installation 1367 was part of a more complex oil press, which included separate crushing and extraction installations. The main component missing in such an industrial oil press is the facility

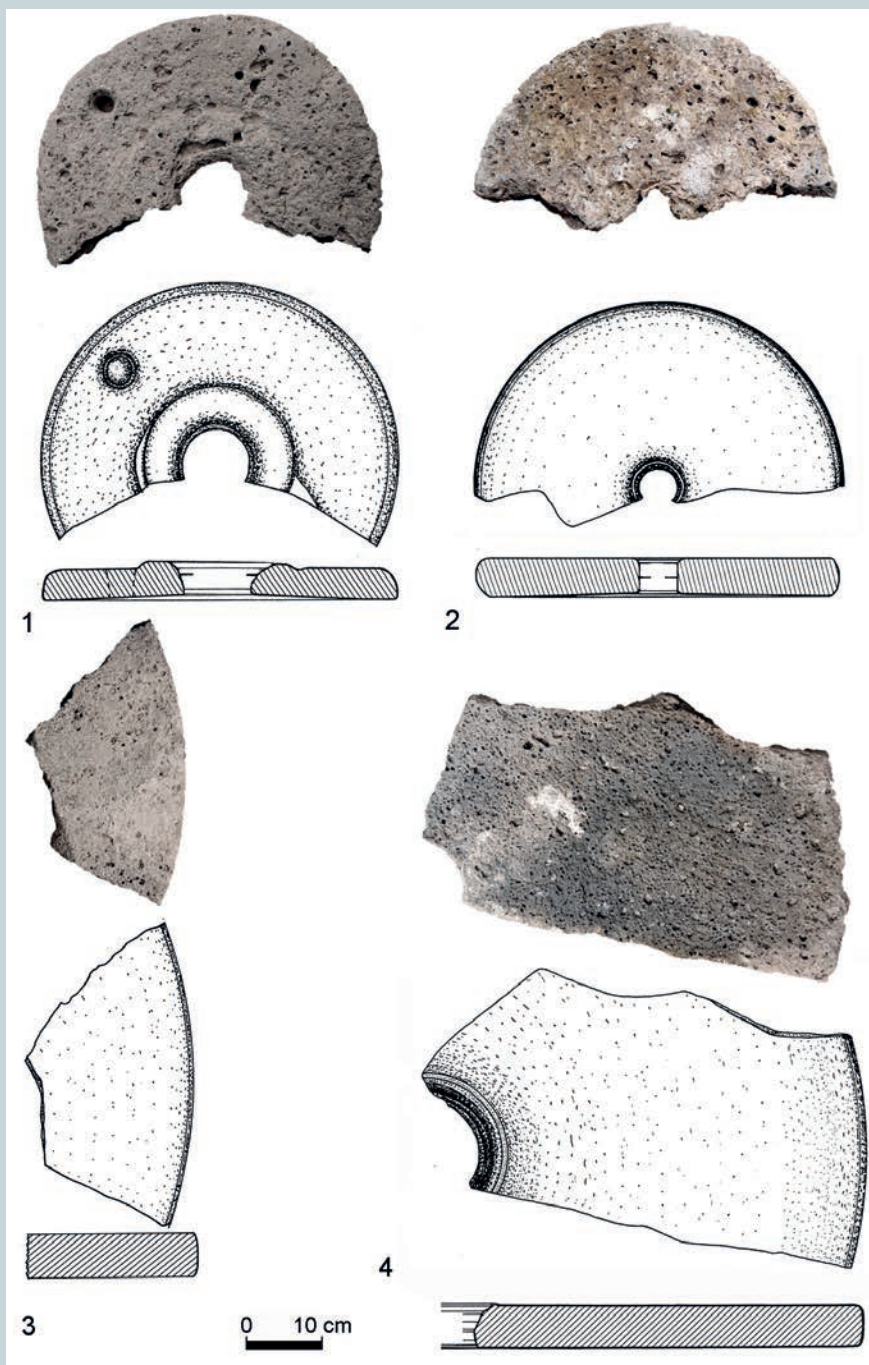


FIG. 13
Additional millstones from the oil press
complex. (Drawing by D. Roshal; photos by
 P. Shrago.)

FIGURE 13

No.	Type	Locus / Basket / Inv	Material	Description
1	Rotary hand mill (upper stone)	1353 / 12683 / 2549	Basalt	Dia. 45 cm. Slightly concave. Low collar around the eye. Conical, worn out handle socket (dia. 3.6 cm). Bottom is worn out.
2	Rotary hand mill (lower stone)	1358 / 12705 / 2547	Basalt	Dia. 50 cm. Flat. Top worn out.
3	Rotary mill (upper and lower stone)	1353 / 12667 / 2539	Basalt	Flat. Top is highly worn out, bottom is much less (probably re-used upside down). Remains of cement on the edge.
4	Rotary mill (upper stone)	1358 / 12704 / 2548	Basalt	Dia. ca 115 cm. Flat. Bottom and eye are worn out.



FIG. 14
A woman operating a stone roller for crushing olives at Beit Jubrin.
(From Matson 1980: fig. 3967.)

used for crushing the olives. It can be assumed that in such a case the mill was operated in the northern courtyard or in the eastward adjoining room, although no opening was found in the wall between the two rooms. The position of the crushing installation and the pressing installation in separate rooms is known from many early oil presses (Magen 1993: figs. 5–6). It is unlikely that this activity was performed in the western adjoining room (L1358) since it was not spacious enough to accommodate the operation of a crushing mill.

It might be that the crushing of olives was done in a small installation, *bodeda* (as described above), but given the dimensions of the beam press, it is more likely that an “industrial” crushing device was used. The usual type of crushing mill includes a horizontal basin and a vertical crusher; this type remained almost unchanged from the Hellenistic period to the present day (Frankel 1999: 68–72). An additional option is the use of large horizontal millstones, similar to those used in flourmills.⁸ Such millstones, in which the upper stone was operated by means of a wooden shaft connected to an animal, were also used for crushing olives. This seems to have been the case in the oil press from the Early Islamic period discovered in Khirbet Diran (Rehovot) (Bouchenino 2007: 122–23, 142, fig. 3). During the twentieth century, large horizontal millstones made of basalt served for crushing olives (to produce oil) and for grinding sesame seeds, whose oil was one of the ingredients for producing sesame sauce (*teḥina*) (Matson 1980: fig. 563;

Avitsur 1994: 111, figs. 111, 148; Ayalon 2012: 217). Indeed in Rooms 1372/1353 and 1358 fragments of such large rotary millstones made of either beach-rock or basalt were found and it is possible that ours served the same purpose.⁹ This may also have been the purpose of our smaller rotary hand mills as they were found in both rooms of the olive oil complex.

Assuming that crushing was done in the room adjoining to the east or in the northern courtyard, Installation 1367 could have been used as a working surface to fill the baskets with the crushed olives before placing them under the press (Matson 1980: fig. 3968; Avitsur 1994: fig. 97; Boas 2010: 193, fig. 58). The baskets were placed on the working surface and filled with mash. The oil flowing during that process was modest but of fine quality and was collected in the pit. Then the baskets were placed under the press. Although it seems difficult to conduct this work in Installation 1367 (due to the close proximity of the press beam), it is not impossible.¹⁰

The device apparently used for olive pressing utilized a wooden beam. Its rear end was anchored in the niche in the town wall, and was thus operated by the principle of a lever. The beam was operated together with Installation 1397. Its western part, measuring 0.55 x 0.55 m, located just opposite the niche, was probably the base for the stone press-bed (that has not survived), upon which baskets with crushed olives were placed. On top of them a wooden pressing board was set, on which the wooden beam pressed. Apparently the squeezed liquid was drained through a groove that was cut along the circumference of the press-bed and from there ran through a funnel at its margins to the eastern shallow basin (0.5 x 0.4 m). Only the lower part of the basin is preserved. Assuming that it needed a certain collecting volume, it is possible to reconstruct the surface of the press-bed next to it to at least 0.30 m above the bottom level of the pit, which is 31.01 m. If the level of the press-bed were higher, it would have meant that the beam was placed on the baskets in too steep of an angle. This was not desirable, as pressing was more effective when the beam was in a more or less horizontal position. Another disadvantage in this press is the distance of the press-bed (L1397) from the rear wall (W1). The closer the pressing baskets are to the

anchoring niche, the more effective the beam (= lever). In this case however the press-bed is more or less in the center of the room. It seems that, in our case, the operators of the olive press were satisfied with a rather simple installation.

It is unclear how the beam was pulled down in order to perform the pressing. It might have been done by hanging relatively small stone weights from the front part of the lever. Another possibility is that heavier weights were connected to the lever by means of wooden winches. When the winches were turned, the beam was lowered and at a certain point the weights were even lifted in the air (for these different possibilities, cf. Dalman 1935: pls. 55–56; Matson 1980: figs. 3969, 3971; Frankel 1994: figs. 32, 35; Porat, Frankel, and Getzov 2012). However, according to the equivalents (see below) it is more likely that the beam was lowered using a wooden screw and a stone weight (Fig. 15). A wooden screw was integrated at the split front of the lever. Its lower part was connected to a stone weight by means of wooden boards which were fastened inside mortices in the stone (Dalman 1935: 217, figs. 59, 61; Frankel 1994: 50ff., fig. 46; Avitsur 1994: 117–21, fig. 118:c [the method in which the screw was connected to the weight was learned from Ayalon's excavation of a deserted traditional oil press at the Arab village of 'Ein Hood]). Turning the screw by means of a shaft caused the lowering of the beam and eventually the lifting of the weight into the air (it was usually placed in a pit to prevent the lever from swinging and tilting, and thus to ensure continuous pressing) (cf. Saller 1946: 170; in our case, however, no evidence for a pit for such a weight was discovered). In light of the dimensions of Room 1372/1353, it seems that the total length of the beam was about 4 m, corresponding to a relatively modest installation. According to ethnographic comparisons, the beam and screw were probably made of hard wood such as oak, which grew abundantly in this area (Lipshits, Biger, and Ayalon 1994: 205–6; see also Roll 1999: 14 for the historical mention of woods in the area of Arsur during the Crusades).

The two pits (L1387 and L1388) dug in front of the installation possibly served to install two wooden posts, which helped stabilize the beam and prevent its tilting

to the side during pressing. Such posts are known from oil presses in the Byzantine and Early Islamic periods (Frankel 2009b: fig. 8.7; Shenhav 2009: fig. 25.6; Ayalon and Dray 2009: fig. 32.4). However, the reason that those pits were not dug one opposite the other

and in a smaller distance from each other is unclear. Admittedly, they are large and quite shallow in relation to the dimensions of the posts that were supposed to be installed in them, but, at the moment, we do not have a better explanation for their use. Alternatively,

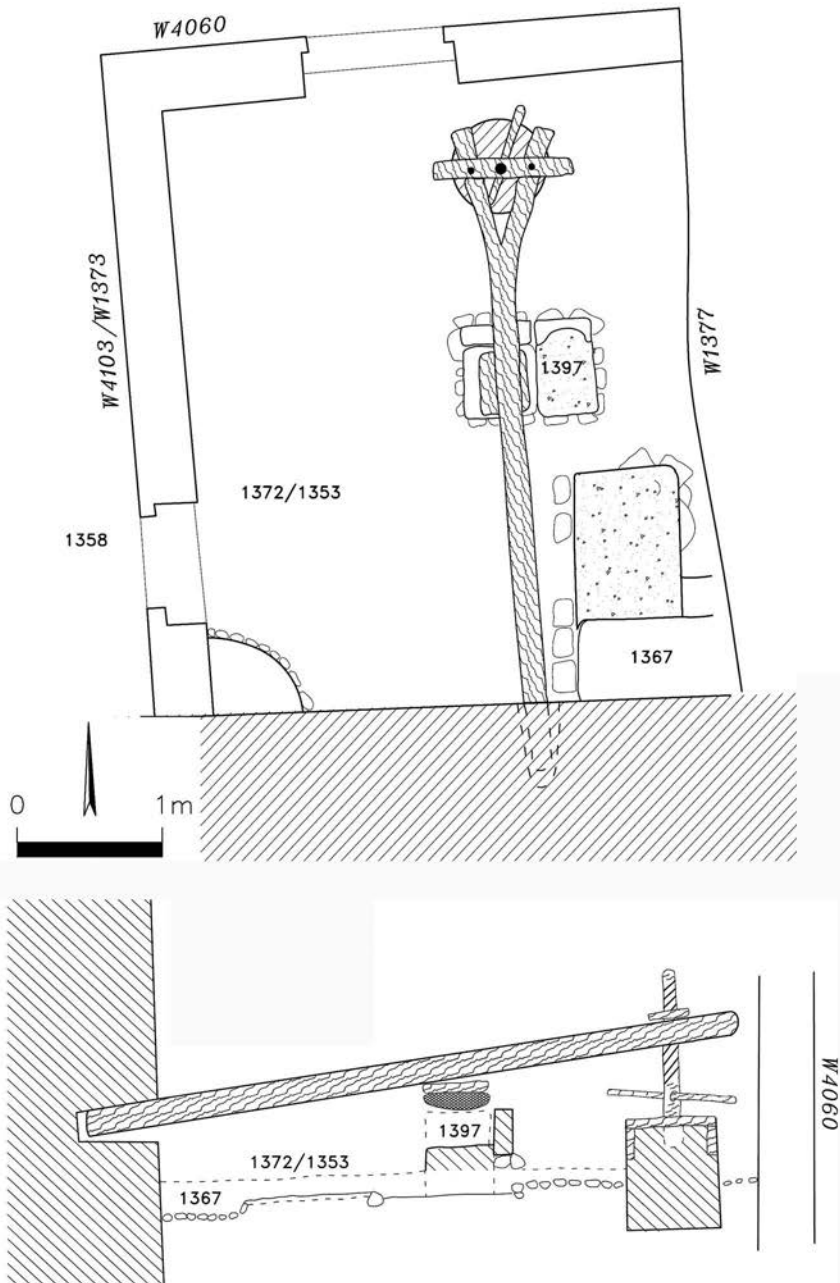


FIG. 15

Suggested schematic reconstruction of the lever-and-screw oil press in Arsur (Area E). (Reconstruction by E. Ayalon; drawing by A. Brauner.)

the pits could have held two jars: one for collecting the extracted oil and the other for the watery lees. It should also be noted that recent traditional presses usually do not feature such supporting posts (cf. Avitsur 1994: figs. 112, 116, 120).

Assuming that the oven in the southwestern corner of the room was a cooking/heating facility, it is possible to relate it to the oil press. It is known that the *gephet* (press residue) was often heated in order to extract more oil (although of lower quality) by means of additional pressing. A larger oven of this type was discovered, for example, at the Byzantine oil press at Shuni (Shenhav 2009: 144, fig. 25.5). Nevertheless, it is possible that the fireplace was used regardless of the oil press.

The pottery and glass finds recovered on the floors of the complex reflect the daily habits of its occupants, probably in the last stage of its use, likely originating from the room's second floor. Some of the metal objects found (especially the iron chisel and the bronze bell) may have had certain functions in the continued upholding of the oil press.

The Oil Press Complex Date of Operation

Among the finds recovered from Rooms 1372/1353 and 1358, pottery was not only the most common but also the best available material to date the oil press complex. As stated above the assemblage can be assigned to the mid-twelfth century based on the archaeological evidence, as a majority can be compared to early- to mid-twelfth-century CE pottery types. Still, establishing a precise date for the ceramic assemblage in context with the olive press is not an easy task. In addition to the difficulties of dating each type accurately, one should bear in mind that pottery types came from Locus 1353, which represent the surface of a floor (F1353) and the ash and stone debris possibly formed during the collapse of a second floor some 0.5 m above it (L1372). It is more than likely that the pottery assemblage was in use while the olive press was functioning. The extent of preservation of most of the vessels eliminates the possibility that pottery from Locus 1353 belongs to the makeup of the floor of the second story or a fill of its foundation. Hence, using the pottery as evidence for an earlier occupation in the olive

press room is not aligned with our understanding of the stratigraphy. However, we cannot exclude the possibility that the pottery assemblage dates to the beginning of the olive press use and not its end. Still the available historical sources mentioning Arsuf (Arsuf) in the twelfth century can enhance our understanding of the oil press complex date of operation and especially its abandonment. Baldwin I conquered the site in 1101 CE, when the first of the seigneurs of the town documented in written sources is Johannes d'Arsuf, whose name comes up in a number of legal documents for about two decades beginning in 1163 CE. At the end of the 1180s and the beginning of the 1190s, far-reaching changes rocked the Latin Kingdom, and naturally, its vassal seigneuries as well. Following the Crusaders' crushing defeat at the Horns of Hattin in the summer of 1187 CE, Arsuf, together with the other coastal cities of Palestine, fell to the Muslims. Given all this, it is likely that the oil press complex was abandoned (even partially destroyed) in the contexts of the site's Ayyubid conquest and occupation (1187–1191 CE), for which we have no written documentation but for the aftermath of the Battle of Arsuf, when a knight by the name of Jacques d'Avesnes (a scion of the house of Avesnes), was buried by order of Richard the Lionhearted in a full requiem service held in the Church of St. Mary in Arsuf (*el moster de la seinte dame*), yet to be identified in archaeological excavations at the site.¹¹ The fact that the assemblage can be generally dated to the twelfth century allows us to use the historical considerations and suggest a date of operation in the twelfth century and a date of abandonment in the late 1180s. The fact that we cannot track changes in many pottery types during the twelfth century lends support to our reconstruction.

The Oil Press Complex in Its Wider Setting

The discovery of an olive press (*molendinum olivarum, massara*) at Crusader Arsuf is not surprising. Although the soil of the coastal plain is not particularly suitable for growing olive trees, the existence of quite a few olive presses from the Roman and Byzantine periods is known from Apollonia in particular and the southern Sharon in general (cf. Roll and Ayalon 1989: 55–57; Roll 1999: 26, figs. 1.12–1.14 [for Apollonia]; and Roll and Ayalon 1989: 204–7; Ayalon 2008: 71–72; Ayalon and

Levy 2011: 45*–50* [for other oil presses in the southern Sharon]). Wood samples taken from layers of the Roman, Byzantine, Early Islamic, and Crusader periods in Apollonia revealed that about one-quarter is comprised of olive wood (Liphschitz 1989: 312; 2007: 42). Olive trees grew at the coast of the southern Sharon both during the Crusader period (Prawer 1972: 361), and during the late nineteenth century (Conder and Kitchener 1882: 251). As for the Crusader period, cases are known in which villagers were required to process the agricultural products in facilities belonging to the king, to the military orders, or to the lord of the manor. The villagers had to pay for this use in addition to taxes on the harvest of the olive groves (Boas 2003: 138–39).¹² However, olive presses are hardly mentioned in Crusader sources, as opposed to the olive groves, including their working and leasing (Benvenisti 1970: 257; 1984: 169).

The location of the oil press in an urban space is not unique. The massive fortification wall provided a good anchoring point for the wooden beam of the olive press, and indeed showed a niche used to operate the lever. A typical example of such a technological solution can be found in a much earlier period—in an assemblage of olive presses from the late Iron Age, which was found at Tel Migne (Ekron) in the Shephelah; many of the olive presses were built along the city wall and the levers were anchored in it (Eitam 1996; Gitin 1996). Proximity to the site's edge at Ekron meant that the production facilities were closer to the unprocessed olives coming into town. Furthermore, the waste products generated by the production process were already close to the town's perimeter rather than in the center of habitable space. In the case of Arsuf, given the fact that thus far we have a single complex, it is likely that it was used for the production of a relatively small quantity of olive oil during the twelfth century.

The room, or its second floor, was also used for residential purposes, as stated by the excavator. It is possible that only during a later stage was a larger facility erected there, and the room, and even a room adjacent to it, became a true “industrial” oil press. In this case, the second floor, if such existed, was the one solely used for residential purposes, as suggested by the varied small finds unearthed in the room (some of which could not be represented here) (Boas 2010: 149, 152). According to

this reconstruction, all remains discovered in the room belong to one single oil press. The finds do not enable us to further speculate the socio-economic aspects of the complex, such as whether it was a private installation or perhaps its owner produced oil for other olive growers as well, receiving payment of about 10 percent of the output (Avitsur 1994: 102–103, fig. 102).

As stressed above, no olive press from the Crusader period, unearthed in systematic-scientific excavations, has been published in full to this date. The number of oil presses that can be attributed to this period is very small when compared to the number of settlements in the Latin Kingdom of Jerusalem (evaluated by some scholars to approximately 1,000 settlements, cf. Prawer 1972: 356–57) (see below). Therefore, a brief review of what is known about this subject is worthwhile, followed by a discussion of several issues related to it.

Olive Oil Industry in the Latin Kingdom of Jerusalem: The Archaeological Perspective

The relatively few Crusader-period oil presses mentioned in the literature will be surveyed below along with a few examples from the Mamluk period that may have their origins in the Crusader period. Most of these oil presses are concentrated around Jerusalem, an area where a relatively abundant number of Crusader sites was explored. It should, however, be noted that in many cases their dating is uncertain (Seligman 2006: 71, n. 9). In certain cases, oil press components were not discovered *in situ*, and can thus be dated to different periods since their design did not change much over centuries (Boas 1999: 77). Additionally, they could have been used secondarily. In other cases, the dating of oil presses to the Crusader period is based on the dating of the building in which they were found (Benvenisti 1970: 257), and not on direct and accurate information about the installation itself. It must be kept in mind that even the dating of these buildings is uncertain since massive Crusader buildings continued to be used for hundreds of years, often until the present day. Below is a list of oil presses attributed to the Middle Ages, presented geographically from north to south.¹³

- *Mi'ilya (Castellum Regis)*. According to Ellenblum, Building 2 in the village, in which an oil press operates today, served the same purpose in Crusader times. This suggestion was made according to a stone discovered there, which was part of a “press whose posts were made of iron,” a type which was used, in Ellenblum’s opinion, only during the Crusader period (1998: 51).¹⁴
- *Jifna*. In a vaulted room within a structure from the Crusader period an “old olive press” was surveyed (Benvenisti 1982: 147, fig. 16), but it is unclear when it was erected (Pringle 2000, 5: 174). According to Boas, the oil press should be dated to the Crusader period because its parts are too large to have been inserted through the structure’s narrow door, thus they must have been installed while the building was still under construction (1999: 77; 2003: 142).¹⁵
- *al-Bira (Magna Mahomeria)*. An oil press existed in a medieval vaulted structure located opposite the church, which was surveyed at the time, but since has been destroyed (Pringle 2000, 6: 151).
- *Beituniyya*. In one of the cellars of a large vaulted structure, the crushing basin of an oil press was found (Benvenisti 1970: 258; 1982: 170; Boas 1999: 77–78; Pringle 2000, 7: 50).
- *el-Qubeibeh (Parva Mahomeria)*. In the village several oil presses were found. The excavator discovered in the area of the monastery eight pressing units (press-beds and cylindrical screw weights), a crushing basin and a crusher, but on Photo 3 an additional crushing basin can be seen in the background (Bagatti 1993: 72, pl. II, photo 19; Boas 2010: 154). Ellenblum notes that two press rollers, which were excavated *in situ* in Crusader dwellings, date with certainty to that period and therefore the other crushing and pressing components should also be dated to the Crusader period, as the site was uninhabited between the late twelfth and the nineteenth centuries (1991: 201–2, 246; 1998: 91). Still one cannot exclude the possibility that some components were produced by the later generations residing at the site. Additional stones belonging to olive presses were discovered throughout the village, indicating an extensive production of olive oil during its existence.¹⁶
- *Nebi Samuel (Monts Gaudii)*. Impressive remains from the Crusader and Mamluk periods were discovered at this site. According to a brochure distributed there, two oil presses were discovered dating to the Crusader period. During a tour of the site (November 26, 1995), Ayalon noticed a room with a niche in the wall for anchoring a beam (next to the Mamluk-period pottery kilns). The room also exhibits a press-bed, stone roller, and different kinds of weights, one re-using an old capital (see below).
- *Abu Ghosh (Fontenoid)*. Ellenblum notes that in the village many parts of crushing installations belonging to oil presses were found. Those remains are similar to others found at Crusader sites in the region (Ellenblum 1998: 117). However, given that these facilities have not changed much for generations, it is hard to accept similarities as evidencing the existence of oil presses from the Crusader period at the site.
- *En Hemed (Aqua Bella)*. In the southern hall of the Crusader estate an oil press was surveyed. According to Benvenisti, all its components that remained (including a crushing basin and a broken crusher) were *in situ*. He also mentions a niche for anchoring the pressing beam in the eastern wall (Benvenisti 1970: 257–58; 1982: 169–70). In the photograph published by Benvenisti, a small screw weight can be seen with side mortices. Roughly opposite the niche for anchoring the beam, a somewhat larger screw weight is seen. Pringle mentions the crushing basin but notes that it is unclear whether it dates to the Crusader period or later (1992: 155, fig. 9; 2000, 5: 174; see also Peled 1999: 250). During a tour of the site (February 19, 1994), Ayalon noted that all the parts were concentrated near the eastern wall, which holds the niche for anchoring the beam. They include: a crushing basin, a crusher which was later converted into a screw weight with trapezoidal-shaped side mortices, a smaller screw weight with similar mortices along its full height, a press-bed, an elliptical collecting basin, shallow vat, grooved stone fragment whose use is not clear, fragments of an additional crushing basin, a fragmented roller,

and more. The wooden parts have disappeared. In fact, it is impossible to determine the date of the oil press, except that the dimensions of the weights indicate a date later than the Early Islamic period (see below).

- *Khirbat Ka'kul*. The remains of a village from the Mamluk period were excavated at the site, which is located north of Jerusalem. In one of the rooms an oil press was discovered from which the crushing basin and parts of the screw press remained *in situ*: a niche for anchoring the beam, a press-bed (?), a stone basin for collecting the sap, and a small screw weight with side mortices along its full height. Two additional screw weights were discovered but not *in situ*, as well as a weight (probably earlier and in secondary use) and a fragment of another crushing basin. The dressing of the weights is of poor quality (Seligman 2006: 34–37, figs. 6:30–32, plan 11).
- *al-Kurum*. At the site north of Jerusalem (Ramot o6), stones of olive oil presses are reported but their nature is not described (Boas 2010: 327).
- *Lifta*. In two vaulted halls of the lower floor of a Crusader structure located at the slope of the village, two oil presses were surveyed which may date to the Crusader period (Boas 2010: 344). In another structure (?), all the stone parts of an olive press were preserved while the wooden components have disappeared (Benvenisti 1970: 257; 1982: 170). During a tour at the site (February 18, 1991), Ayalon documented two assemblages of olive presses. The northern one includes two olive presses in two adjacent halls. One features a crushing basin and a crusher and opposite them, a niche for anchoring the beam was found in the wall. The remains of the beam have been examined and were found to be made of almond (*Prunus dulcis*). Opposite the niche is a small cylindrical screw weight with side mortices, which stands in a pit installed in the floor.¹⁷ In the second hall the crushing basin and the crusher were preserved, as well as the beam that was made of oak (*Quercus calliprinos*), found anchored in a niche to the wall. A small cylindrical weight with side mortices and another crusher that blocked a side door were also found. In light of the preservation of the wooden parts, it seems likely that these installations are from the late Ottoman period (at the earliest), and do not date to the Crusader period. The southern olive press, near the spring, is more recent and includes a crushing basin with concrete additions and fragments of a direct pressure screw press made of iron; outside the building a screw weight was also found.
- *Bethany, al-'Eizariya*. In a large vaulted structure which belongs to a monastic complex an olive press was found, including a crushing basin and crusher, as well as a screw press, of which the beam and the wooden screw attached to it survived. Attached to the bottom of the screw was a small stone weight installed in a pit in the ground (Saller 1946: 170; 1957: 104, pls. 68–69) (Fig. 16).¹⁸
- *Wadi al-Haramiya*. On the ground floor of a large structure at the site, a crushing basin and a crusher were found. They were dated to the Crusader period based on their proximity to the village and the two coins found in the room (Yehiel Zelinger, pers. comm.; Boas 2010: 154, fig. 45, erroneously captioned as a flour mill from Har Hotzvim).
- *Beit Jibrin (Bet Gibelin)*. Kloner published a photograph of an olive press which he dated to the Mamluk–early Ottoman periods. This press was installed next to the western wall of the Crusader church (Kloner 1987: fig. 8). In the wall a niche for anchoring the beam was carved (similar to the one recorded in Arsur), and at its feet a large stone was found into which a press-bed and a small collecting vat were cut. Next to it a round crusher was found, which was originally surrounded by a row of stones, creating a basin-like feature. The press beam was lowered by a simple wooden pulley and a stone weight, as documented by the early twentieth-century American Colony photographers (Matson 1980: figs. 3968, 3969, 3971; Avitsur 1994: figs. 97, 116). Elsewhere additional (later) oil presses are described (Kloner and Assaf 1998; Kloner and Gamil 1998).¹⁹

Changes in Olive Oil Production during the Medieval and Pre-Modern Periods

The study of the archaeological remains of olive oil production over the last two thousand years reveals a fascinating picture. During the Roman and Byzantine periods, there is a considerable increase in the number of olive presses, in their scale, and in the technological

development of their installations (e.g., Ayalon, Frankel, and Kloner 2009). During the late Ottoman period, again we find a considerable number of olive presses, sometimes up to ten in one village (Dalman 1935: *passim*; Saller 1946: 165–71; Avitsur 1994). Surprisingly this abundance is opposed by a scarce number of olive oil presses excavated and dated to the Fatimid, Ayyubid, Crusader, and Mamluk periods.²⁰ Amar points at a gradual process



FIG. 16

An Ottoman-period oil press erroneously dated to the Crusader period at the Franciscan monastery of Bethany. (Photo by D. Yonai.)

of decline in agriculture during the Mamluk period and listed political, economic, and religious reasons for it. However, in his opinion olive oil production and the soap industry were only partially affected by the above reasons and even expanded in Samaria (Amar 2003: 149–58, and esp. 153; see also Peled 1999: 251).²¹ According to Boas, the oil production may have expanded thanks to the opening of the western markets and an increased demand for olive oil by the churches (1999: 77). However, it is clear that the picture is incomplete because of the relative scarceness of excavated and published material concerning these installations from these later periods, especially in areas with significant growth of olives, such as Samaria and the Galilee.

In addition to changes in the number of oil presses, which occurred from the classical to the medieval and later periods, we should also point out a few technological changes in olive oil production during the Middle Ages, which are hardly discussed in the scientific literature. Although the olive presses are in a sense conservative in their design and distribution of different types throughout the country, two changes should be observed in the lever-and-screw press:

1. While Byzantine olive presses usually exhibit two (sometimes even three) presses for each crushing installation (in order to allow a continuous operation, as the pressing process lasts at least twice as long as the crushing), the Ottoman olive presses display only one press.
2. Presses of the Roman to the Early Islamic period feature a heavy weight (weighing some 2–4 tons). By contrast, Ottoman presses are characterized by much smaller weights with dressing of poorer quality (Seligman 2006: 37).²² They are of almost identical form and operation as those of earlier periods, although weighing only about half a ton and sometimes their size is disproportionate to the large beams (e.g., Dalman 1935: figs. 59, 61; Hamilton 1935: pl. 66, 1–2; Avitsur 1994: figs. 118, 122; Ayalon 1994: fig. 177; Frankel 2010: fig. 2). In many cases these weights are made of secondary-use column capitals. The small weights have side mortices along their full height, onto which wooden planks were fastened and designed to connect the screw to the

weight, unlike those of earlier times in which the mortices were confined to the weights' upper part (Seligman 2006: 36). The few weights dated to the Crusader period are similar in dimension and shape to those of the Ottoman period and hence, the drastic change in size—whose reason still remains unclear—probably took place during the later part of the Early Islamic period, as the Umayyad weights were still of Byzantine type and size. It is remarkable that, although identical in form, we know almost no later olive press which made secondary use of the large and more effective weights of the earlier periods (cf. Saller 1946: 170, pls. 5, 2; 27, 1 for one such isolated example [as far as we know] of a nineteenth-century olive press at 'Ein Kerem).

The changes described above reflect the decline in the quality and dimensions of the olive presses and their installations, as well as a decline in the extent of olive oil production between the classical and medieval periods.²³ A partial explanation for this phenomenon may lie in social circumstances (rather than the level of technological development), such as the preference in Arab villages to produce oil in an olive press that belongs to the family or to the *ḥamullah* ("clan"). This is one reason why in a village dating to the Byzantine period, one can find larger isolated olive presses while an Ottoman village could feature up to ten presses.

Conclusions

The Crusader oil press complex of Arsuf is the first installation of its kind to be systematically excavated and published. The oil press complex and its installations exhibit known features in periods that preceded and followed its date of operation. Therefore it constitutes a kind of "anchor-point" in the historical development of olive oil production technology in the Holy Land and from that stems its importance. The Arsuf press fills some of the gaps in our knowledge between the large-scaled, varied, and sophisticated Byzantine oil presses and those of the late Ottoman (pre-modern) industry, which were smaller and simpler but better preserved (wooden parts are included) and documented. Our historical knowledge

on the site's Frankish occupation at the time of its use, suggests that some of its inhabitants used (and adapted) local knowledge in producing olive oil, which was most common in Palestine during the centuries before and after the Crusades. It is impossible, of course, to point to the ethnic identity of the press operators based on the archaeological finds alone.

Notes

This article is dedicated to our friend and educator, the late Professor Israel Roll (1937–2010), in appreciation of his lengthier investigations of Apollonia/Arsuf/Arsur.

1. The first salvage excavations at Apollonia-Arsuf were carried out in 1950, north of the medieval town wall, by the Israel Department of Antiquities, directed by Immanuel Ben-Dor and later by Penuel Kahane. The latter published only an abridged preliminary report (Kahane 1951: 42–43; Perkins 1951: 86–87, fig. 11, for an English summary). A completely new approach, that of exploring the site in a historically and methodologically more coherent way, began in 1977 by Israel Roll. Since then, Roll, who directed 17 seasons of excavations until 2004, explored large sections of the site, establishing for the first time a chronological and developmental framework for Apollonia-Arsuf. In 2006, an eighteenth season of excavations at the site was carried out, a transition during which the directorship and responsibility over the future excavations at Apollonia-Arsuf were transferred from Roll to Oren Tal. For an overview on the site and its history of excavations, see Roll 1999. A more updated overview can be found in Galor, Roll, and Tal 2009 and in Tal and Roll 2011, which focuses on the site's latest phases of occupation. On the site's hinterland throughout its periods of existence, see Roll and Ayalon 1989.
2. For other historical overviews, see, e.g., Runciman 1954: 318; Marshall 1992: 115; Thorau 1995: 161–62. The number of dead warriors, as based on equivocal historical sources, is obviously estimated. The archaeological evidence is not in total agreement with the historical documentation (i.e., the accounts of Ibn 'Abd al-Zāhir 1976: 235–43). These accounts present many details, but the general impression is far from clear. Still, it appears that the town was under siege for 35 days (from March 21/22 to April 26, 1265), while the fighting over the castle lasted three days (April 26–29, 1265). (For our reservations, see Jackson-Tal and Tal 2013: 87–89, esp. n. 12.)
3. The oil press was excavated during the ninth season (IAA license no. G-116/1992), while the area to its north was excavated in the fourteenth and fifteenth seasons (IAA licenses nos. G-6/2000 and G-28/2002). D. Rochelle was the area supervisor in 1992 and drew the finds recovered from that area. A. Brauner drew the plan for publication and P. Shrago photographed the finds (both are from the Institute of Archaeology, Tel Aviv University). The publication of the oil press forms part of a Deutsche Forschungsgemeinschaft-funded project (co-headed by B. Scholkmann [Universitäten Tübingen] and O. Tal [Tel Aviv University]), titled “Die kreuzfahrerzeitliche Stadt Apollonia/Arsur in Israel: Struktur—Kulturadaption—Stadt—Umland—Beziehungen” (2012–2014; GZ: SCHO 520/14-1). This project aims at a better understanding of the European and local cultural influences that dictated the structure and organization of the town of Arsuf and its hinterland, by analyzing the data of past excavations of Crusader remains in several areas as well as excavating new Crusader buildings with improved excavation methods and techniques.
4. Unfortunately we did not manage to trace all the finds shown in the illustrations; hence, our observations in certain cases are limited. Untraceable artifacts are marked by an asterisk next to their serial number in the description table. Other finds mentioned in the excavation records, such as whetstones, a ring, bone inlays, a spindle whorl, and a stone pestle, could not be traced at all.
5. The pottery illustrated represents about 17 percent of the ceramic material recovered from Loci 1372/1353 and 1358. Complete restorable vessels and larger fragments were drawn. Room 1372/1353 yielded the following pottery fragments: imitation of Fatimid Luster Ware: 10; gritty bowls: 8; heavy bowls: 11; cooking-pots: 9; frying pans: 14; amphorae: 2; storage jars: 6; for a total of 60 fragments. Room 1358 yielded the following pottery fragments: imitation of Fatimid Luster Ware: 23; gritty bowls: 10; heavy bowls: 6; cooking-pots: 3; frying pans: 4; amphora: 1; storage jars: 7; for a total of 54 fragments.

ETAN AYALON is an archaeologist and ethnographer, and is the curator of the Man and His Work Center at the Eretz Israel Museum in Tel Aviv, Israel.

OREN TAL is a professor of classical archaeology at the Jacob M. Alkow Department of Archaeology and Ancient Near Eastern Cultures of Tel Aviv University in Israel and the current director of the Apollonia-Arsuf Excavation Project.

ELISABETH YEHUDA is a post-doctoral student at the Jacob M. Alkow Department of Archaeology and Ancient Near Eastern Cultures of Tel Aviv University in Israel and a team member of the Apollonia-Arsuf Excavation Project.

6. An intact example with a holed upper part (yet unpublished) is known from a Byzantine burial cave at HaGolan Street, Tel Aviv.
 7. The term *bodeda* in the present research is ascribed to a small installation surrounded by a channel that leads to a collecting pit but the fact is that the term refers to a plain installation (the doubling of the *-bd-* [= “beam” in Hebrew, defining the whole oil press] comes to signify diminution).
 8. The crushing of olives—albeit in modest amounts—by means of regular hand millstones of the type found in these rooms is also documented in ethnographic accounts (cf. Litchfield 1982). A similar phenomenon was recently inspected in Madeba (Jordan), where the pits were removed before the crushing (Peter Warnock, pers. comm.).
 9. It may be added that a large millstone with a central hole was discovered integrated in the floor of a large oven in the Crusader castle (1241–1265 CE). Since there are no streams in the area of Arsuf, it seems unlikely that a water-powered flourmill operated there, so it appears that these millstones were intended for another facility in the site such as the oil press. Another possibility is that the millstones were brought to Arsuf for secondary use from the Yarkon flourmills that were in use during the Crusader period (e.g., el-Haddad [“Ten Mills”] and el-Jerishe [“Seven Mills”]; cf. Avitsur 1963: 79–90; Benvenisti 1970: 252; Ayalon n.d.: 44–52).
 10. The photo taken at Beit Jubrin (Matson 1980: fig. 3968; Avitsur 1994: fig. 97) shows that the rear end of the beam could have been removed from the anchoring niche and put aside in order to make room for the filling of the baskets.
 11. With the peace treaty signed between the Christians and the Muslims in September 1192 CE, the seigneurie of Arsuf was formally restored to the Crusaders. Control returned to a noble from the original family of the seigneurs of Arsuf, whose name was Johannes, apparently the son of the Johannes who had ruled the seigneurie before the battle of Hattin, who was killed in 1198 CE in an unusual hunting accident. As Johannes II had no children by his wife, Heloise de Brie, control of the seigneurie of Arsuf passed to his sister, Melisende, who had no interest in managing the seigneurie herself, and therefore in that same year (1198 CE) she married a rather obscure noble by the name of Terricus d’Orca. Melisende bore her husband no less than seven daughters, none of whom survived. Terricus held the formal title of *dominus d’Arsuf*, but not for long; he died a few years after 1200 CE. Melisende married again fairly soon thereafter. But this time, she wed one of the most prominent Crusader aristocrats of the first third of the thirteenth century, Jean d’Ibelin. Thus, the seigneurie of Arsuf came under the control of the Ibelin family, one of the most powerful families in the Latin East. For the site’s Crusader history, see Roll 1999: 11–18; Tal and Roll 2011: [13]–[20]. Curiously enough, testimonies of early thirteenth-century pilgrims attest to the site as a deserted, hardly inhabited place (Beyer 1950: 157; Pringle 2012: 86, 109, where the accounts of Wilbrand von Oldenburg [1211–1212] and Thietmar [1217–1218] appear.
- We are indebted to Hauke Kenzler who provided us with these references). It is likely then that only in the later years of Jean d’Ibelin (Vieux Sire de Baruth) (that is late 1220s/early 1230s) or even after his death in 1236 CE, and under his fourth son, Jean II d’Ibelin d’Arsuf (who reached the status of *bailli* and *conestable* of the Latin Kingdom of Jerusalem), Arsuf was (heavily) resettled. The historical testimony on the building of its renowned castle in 1241 CE (“Johan de Ybelin, fis dou seignor de Baruth, comensa a fermer le chateau d’Arsuf”) supports this understanding.
12. Those taxes could reach, like in the case of Akhziv up to 40 percent of the yield (cf. Ellenblum 1998: 67–71).
 13. The exceptionally designed wine, oil, or sugar presses from the Crusader-period western Galilee (Frankel’s Manot press) are excluded from this list as they probably were created from European technology (cf. Frankel 1999: 136–37). Some of the traditional oil presses mentioned below were surveyed by Ayalon with the help of Nili Greitzer, Deborah Yonai, Hagit Sorek, and Yehoshua (Yeshu) Dray.
 14. Ellenblum attributes this suggestion to Frankel but gives no reference. The use of iron posts is not known in ancient periods (Crusader included, cf. Frankel 1999: 122–25). It was common in Ottoman-period wooden (and wooden and stone) presses (even in Mi’ilya, cf. Avitsur 1994: fig. 124).
 15. It is unclear whether Boas is referring to the beam or to the millstones and his conclusion is not well sounded as the on-going maintenance of such installations clearly took into consideration the possibility of replacing them.
 16. In many houses basins and settling pits were recorded for which Bagatti had no single interpretation. He identified the installations in two of the rooms as equipment used for wine production while describing the installation in another room for oil production (1993: 90). This opinion was accepted by Ellenblum (see above), yet justifiably rejected by Boas. The latter rightfully identifies these installations as wine presses (2010: 334, n. 120) featuring floors for grape treading and adjoining vats used for collecting the must (Boas 1999: 78).
 17. Wood remains were identified by Nili Lipshchitz. Such pits are characteristic of lever-and-screw presses of the Roman and Byzantine periods, as well as of the Ottoman period. The lowering of the level of the weight by installing it in a pit enabled the balancing of the lever during the pressing in a comfort level. Recently, Y. Dray has suggested (in a lecture given at Ben-Gurion University, January 19, 2012) that while the larger Roman and Byzantine-periods stone weights which were installed in pits could have been lifted up in the process of pressing, the smaller stone weights (found in Arab traditional oil presses) were intentionally anchored in the pits by filling them with dirt, making these installations into direct pressure screw presses. According to Dray the anchoring of the stone weights could explain why medieval–pre-modern stone weights are smaller than those of the classical periods. Still, the evidence as we know it provides a more complex picture, as many traditional oil presses display a freely-placed screw weight in a pit which indeed hangs in the air during

- operation (e.g., in 'Ein Hood, Lifta, Bethany, and Beit Sahour; for the latter, see Dalman 1935: 217, fig. 60).
18. Boas correctly points out that it is difficult to date installations of this type because they barely changed during many periods (1999: 77). During a tour at the site (February 16, 1994), Ayalon has recorded all the pieces still *in situ* except for the stone weight. A postcard sold on the premise shows the oil press with a caption of a twelfth-century date. Still, the preservation of the wood remains points to a later, more recent dating.
 19. Namely, in the northern aisle of the Crusader church, which was transformed into a mosque, an olive press was installed during the nineteenth century. It included a crushing installation consisting of a marble basin and a column drum used as roller (perhaps the one in Fig. 14 above), a pressing installation made of an earlier crushing basin in secondary use, reinforced with concrete and metal, and perhaps a screw press. Another Ottoman-period installation was found near the gate of the Crusader castle, from which the crusher survived in secondary use. Next to it olive pits and ashes were found. During the time of the British Mandate, an olive press was documented outside the eastern wall of the castle. It featured a crushing basin reinforced with concrete and a wooden lever-and-screw press (cf. Hamilton 1935: pl. 66, 2).
 20. Under the Umayyads and Abbasids many Byzantine-period oil presses continued to be operated, while many others were erected in abandoned churches and monastic complexes (cf. Ayalon 2008: 87). Still, we cannot accept the thesis put forward by Magen that the introduction of the lever-and-screw press took place in the Early Islamic period (Magen 2008). There is no doubt that many Byzantine-period olive presses have integrated the lever-and-screw press in their operation, e.g. Zur Natan (Ayalon and Dray 2009: 175–76) and in Ḥorbat Gelilot (Ayalon and Levy 2011: 45*–50*; Calderon 2011: 75*–77*). For additional examples, see Frankel 2010.
 21. A similar, more dramatic process occurred with wine production. Amar attributes this crisis to the Mamluk period based on historical sources (Amar 2003: 154). Still, the study of the archaeological remains shows that by the eighth/ninth centuries most Roman-Byzantine winepresses were abandoned or destroyed (cf. Ayalon 1997). In the later periods (Crusader period included) relatively few smaller winepresses are known to exist (see Peled 1999: 251 for an alternative view). Some of these installations were engaged in grape-honey production rather than wine (cf. Dalman 1935: figs. 95–96 [larger]; Tsioni 2010: 222–44; Boas 2010: 152–54, 327).
 22. Seligman notes that the medieval weights were more roughly carved (unlike earlier examples) but does not refer to their size. He adds that the capacity of the collecting vats in these oil presses is smaller than that of the earlier (classical) examples, which he sees as another testimony to the lower quality of the late olive oil installations.
 23. It is interesting to note in this context the existence of small wine presses within Crusader houses (cf. Yehuda 2010: 92), as opposed to the large installations of earlier periods, which were located outside the settlements. Was this a new phenomenon, brought by the Crusaders from Europe, where it usually rains during grape harvest season? The Arsuf installation described here may point to the possibility that small oil presses were also installed within domestic rooms in this period, but more data is needed in order to reach definite conclusions.

References

- Amar, Z. 2003. Transformation in the Agriculture of al-Sham during the Mamluk Period (1250–1517 CE). In *The Rural Landscape of Ancient Israel*, ed. A. M. Maeir, S. Dar, and Z. Safrai, 149–58. BAR International Series 1121. Oxford: Archaeopress.
- Amitai, R. 2005. The Conquest of Arsuf by Baybars: Political and Military Aspects. *Mamluk Studies Review* 9/1:61–83.
- Arnon, Y. D. 2008. *Caesarea Maritima: The Late Periods (700–1291 CE)*. BAR International Series 1771. Oxford: Archaeopress.
- Avisar, M. 1996. The Medieval Pottery. In *Yoqne'am I: The Later Periods*, ed. A. Ben-Tor, M. Avisar, and Y. Portugali, 75–172. Qedem Reports 3. Jerusalem: Institute of Archaeology, The Hebrew University of Jerusalem.
- Avisar, M., and E. J. Stern. 2005. *Pottery of the Crusader, Ayyubid, and Mamluk Periods in Israel*. IAA Reports 26. Jerusalem: Israel Antiquities Authority.
- Avitsur, S. 1963. *Survey of the Water Power Installations in Eretz Israel*. Tel Aviv: Avshalom Institute for Homeland Studies (Hebrew).
- Avitsur, S. 1976. *Man and His Work: Historical Atlas of Tools & Workshops in the Holy Land*. Jerusalem: Carta/Israel Exploration Society (Hebrew).
- Avitsur, S. 1994. Olive Oil Production in the Land of Israel—Traditional to Industrial. In *History and Technology of Olive Oil Production in the Holy Land*, ed. E. Ayalon, 91–157. Translated by J. C. Jacobson, from Hebrew. Arlington, VA: Oléarius Editions/Tel Aviv: Eretz Israel Museum.
- Ayalon, E. n.d. The Yarkon Flour Mills. In *The Yarkon Basin: Sites and Travelling Routes*, ed. R. Bar-Ner and E. Buch, 44–52. Tel Aviv: The Society for the Protection of Nature in Israel (Hebrew).
- Ayalon, E. 1994. Reconstructing a Traditional Olive Oil Plant at the Eretz Israel Museum, Tel Aviv. In *History and Technology of Olive Oil Production in the Holy Land*, ed. E. Ayalon, 159–88. Translated by J. C. Jacobson, from Hebrew. Arlington, VA: Oléarius Editions/Tel Aviv: Eretz Israel Museum.
- Ayalon, E. 1997. The End of the Ancient Wine Production in the Central Coastal Plain. In *Hikrei Eretz: Studies in the History of the Land of Israel; Dedicated to Prof. Yehuda Feliks*, ed. Z. Safrai, Y. Friedman, and J. Schwartz, 149–66. Ramat Gan: Bar Ilan University Press (Hebrew).
- Ayalon, E. 2008. A Church and Village Remains from the Byzantine Period at Pardessiya in the Sharon. *'Atiqot* 58:67–89 (Hebrew; English summary, pp. 67*–68*).

- Ayalon, E. 2012. *Images from the Land of the Bible: People, Life and Landscapes, 1898–1946*. Tel Aviv: Eretz Israel Museum.
- Ayalon, E., and Y. Dray. 2009. Byzantine “Industrial” Oil Presses at Zur Natan. In *Oil and Wine Presses in Israel from the Hellenistic, Roman and Byzantine Periods*, ed. E. Ayalon, R. Frankel, and A. Kloner, 175–79. BAR International Series 1972. Oxford: Archaeopress.
- Ayalon, E., and Y. Levy. 2011. Ḥorbat Gelilot (el-Jelil): Excavations on the Fringes of a Roman–Byzantine Period Village in the Sharon Plain. *‘Atiqot* 66:17*–61* (Hebrew; English summary, pp. 156–57).
- Ayalon, E., R. Frankel, and A. Kloner, eds. 2009. *Oil and Wine Presses in Israel from the Hellenistic, Roman and Byzantine Periods*. BAR International Series 1972. Oxford: Archaeopress.
- Bagatti, B. 1993. *Emmaus-Qubeibeh: The Results of Excavations at Emmaus-Qubeibeh and Nearby Sites (1873, 1887–1890, 1900–1902, 1940–1944)*. Translated by R. Bonnanno, from Italian. Jerusalem: Franciscan Printing Press.
- Benvenisti, M. 1970. *The Crusaders in the Holy Land*. Jerusalem: Israel Universities Press.
- Benvenisti, M. 1982. Bovaria–Babriyya: A Frankish Residue on the Map of Palestine. In *Outremer: Studies in the History of the Crusading Kingdom of Jerusalem Presented to Joshua Prawer*, ed. B. Z. Kedar, H. E. Mayer, and R. C. Smail, 130–52. Jerusalem: Yad Ben-Zvi.
- Benvenisti, M. 1984. *Cities and Sites in Eretz Israel in the Crusader Period*. Kardom 35–36. Jerusalem: Ariel (Hebrew).
- Beyer, G. 1950. Die Kreuzfahrergebiete Südwestpalästinas. *Beiträge zur biblischen Landes- und Altertumskunde* 68/2:148–92.
- Boas, A. J. 1999. *Crusader Archaeology: The Material Culture of the Latin East*. London: Routledge.
- Boas, A. J. 2003. Street Villages and Rural Estate Centers: The Organization of Rural Settlement in the Latin Kingdom of Jerusalem. In *The Rural Landscape of Ancient Israel*, ed. A. M. Maeir, S. Dar, and Z. Safrai, 137–48. BAR International Series 1121. Oxford: Archaeopress.
- Boas, A. J. 2010. *Domestic Settings: Sources on Domestic Architecture and Day-to-Day Activities in the Crusader States*. Medieval Mediterranean 84. Leiden: Brill.
- Bouchenino, A. 2007. Building Remains and Industrial Installations from the Early Islamic Period at Khirbat Deiran, Rehovot. *‘Atiqot* 56:119–44 (Hebrew; English summary, pp. 84*–85*).
- Calderon, R. 2011. The Pottery from Ḥorbat Gelilot. *‘Atiqot* 66:63*–78* (Hebrew; English summary, p. 158).
- Conder, C. R., and H. H. Kitchen. 1882. *The Survey of Western Palestine: Memoirs of the Topography, Orography, Hydrography, and Archaeology*, Vol. 2. London: Committee of the Palestine Exploration Fund.
- Dalman, G. 1935. *Arbeit und Sitte in Palästina*. Vol. 4: *Brot, Öl und Wein*. Schriften des deutschen Palästina-Instituts 7; Beiträge zur Förderung christlicher Theologie, 2. Reihe, Sammlung wissenschaftlicher Monographien 33. Gütersloh: C. Bertelsmann. Repr., Hildesheim: G. Olms, 1964.
- Delaville le Roulx, J. 1883. *Les archives, la bibliothèque et le trésor de l'ordre de Saint-Jean de Jérusalem à Malte*. Bibliothèque des Écoles françaises d'Athènes et de Rome 32. Paris: E. Thorin.
- Eitam, D. 1996. The Olive Oil Industry at Tel Migne-Ekron during the Late Iron Age. In *Olive Oil in Antiquity: Israel and Neighbouring Countries from the Neolithic to the Early Arab Period*, ed. D. Eitam and M. Heltzer, 167–96. History of the Ancient Near East, Studies 7. Padova: Sargon.
- Ellenblum, R. 1991. *Frankish Rural Settlement in Crusader Palestine*. PhD diss., The Hebrew University of Jerusalem.
- Ellenblum, R. 1998. *Frankish Rural Settlement in the Latin Kingdom of Jerusalem*. Cambridge: Cambridge University Press.
- Frankel, R. 1994. Ancient Oil Mills and Presses in the Land of Israel. In *History and Technology of Olive Oil Production in the Holy Land*, ed. E. Ayalon, 19–89. Translated by J. C. Jacobson, from Hebrew. Arlington, VA: Oléarius Editions/Tel Aviv: Eretz Israel Museum.
- Frankel, R. 1999. *Wine and Oil Production in Antiquity in Israel and Other Mediterranean Countries*. JSOT/ASOR Monograph Series 10. Sheffield: Sheffield Academic.
- Frankel, R. 2003. Mills and Querns in Talmudic Literature: A Reappraisal in Light of Archaeological Evidence. *Cathedra* 110:43–60 (Hebrew; English abstract, p. 188).
- Frankel, R. 2008. Corn, Oil, and Wine—Food Processing and Food-Processing Installations in Galilee in the First Century CE. In *The Great Revolt in the Galilee*, curated by O. Guri-Rimon, 19*–28*. Hecht Museum Exhibition Catalog 28. Haifa: Hecht Museum.
- Frankel, R. 2009a. Introduction. In *Oil and Wine Presses in Israel from the Hellenistic, Roman and Byzantine Periods*, ed. E. Ayalon, R. Frankel, and A. Kloner, 1–18. BAR International Series 1972. Oxford: Archaeopress.
- Frankel, R. 2009b. The Oil Presses from Kh. el-Quseir. In *Oil and Wine Presses in Israel from the Hellenistic, Roman and Byzantine Periods*, ed. E. Ayalon, R. Frankel, and A. Kloner, 53–64. BAR International Series 1972. Oxford: Archaeopress.
- Frankel, R. 2010. Lever-and-Screw Presses: A Note. *Israel Exploration Journal* 60:94–97.
- Galili, E., and J. Sharvit. 2001. A Millstone Quarry on the ‘Akko Coastline. *‘Atiqot* 42:73*–78* (Hebrew; English summary, pp. 202–4).
- Galor, K., I. Roll, and O. Tal. 2009. Apollonia-Arsuf between Past and Future. *Near Eastern Archaeology* 72:4–27.
- Getzov, N. 2000. An Excavation at Ḥorbat Bet Zeneta. *‘Atiqot* 39:75*–106* (Hebrew; English summary, pp. 202–4).
- Gitin, S. 1996. Tel Migne-Ekron in the 7th Century B.C.: City Plan Development and the Oil Industry. In *Olive Oil in Antiquity: Israel and Neighbouring Countries from the Neolithic to the Early Arab Period*, ed. D. Eitam and M. Heltzer, 219–42. History of the Ancient Near East, Studies 7. Padova: Sargon.
- Hamilton, R. W. 1935. Note on a Chapel and Winepress at ‘Ain el Jedide. *Quarterly of the Department of Antiquities in Palestine* 4:111–17.

- Ibn 'Abd al-Zāhir, M. 1976. *Al-Rawḍ al-Zāhir fī Sirat al-Malik al-Zāhir*. Edited by 'Abd al-'Aziz al-Khuwayṭir. Riyadh: al-Khuwayṭir.
- Jackson-Tal, R.-E., and O. Tal. 2013. Crusader Glass in Context: The Destruction of Arsuf (Apollonia-Arsuf, Israel), April 1265. *Journal of Glass Study* 55:85–100.
- Kahane, P. 1951. Rishpon (Apollonia); B. *Bulletin of the Department of Antiquities of the State of Israel* 3:42–43 (Hebrew).
- Khamis, E. 1996. The Metal Objects. In *Yoque'am I: The Later Periods*, ed. A. Ben-Tor, M. Avissar, and Y. Portugali, 218–35. Qedem Reports 3. Jerusalem: Institute of Archaeology, The Hebrew University of Jerusalem.
- Kloner, A. 1987. Crusader Bet Govrin—An Archaeological Survey. In *The Crusaders in Their Kingdom 1099–1291*, ed. B. Z. Kedar, 132–47. Jerusalem: Yad Ben-Zvi (Hebrew).
- Kloner, A., and E. Assaf. 1998. Bet Guvrin, 1992–1993. *Excavations and Surveys in Israel* 17:134–39.
- Kloner, A., and D. Gamil. 1998. Bet Guvrin, 1992–1993. *Excavations and Surveys in Israel* 17:129–33.
- Lester, A. 2004. The Glass. In *Excavations at Tiberias, 1973–1974: The Early Islamic Periods*, by D. Stacey, 166–220. IAA Reports 21. Jerusalem: Israel Antiquities Authority.
- Litchfield, C. 1982. Extracting Olive Oil with a Rotary Hand Quern. *Transactions of the International Molinological Society* 5:340–42.
- Lipshchitz, N. 1989. Ancient Vegetation of the Southern Sharon. In *Apollonia and Southern Sharon: Model of a Coastal City and Its Hinterland*, ed. I. Roll and E. Ayalon, 309–13. Tel Aviv: Hakibbutz Hameuchad/Israel Exploration Society (Hebrew).
- Lipshchitz, N. 2007. *Timber in Ancient Israel: Dendroarchaeology and Dendrochronology*. Sonia and Marco Nadler Institute of Archaeology Monograph Series 26. Tel Aviv: Emery and Claire Yass Publications in Archaeology.
- Lipshchitz, N., G. Biger, and E. Ayalon. 1994. The Use of Wood in Installations of Traditional Oil Extraction Plants in Eretz Israel. *Israel—People and Land, Eretz Israel Museum Yearbook* 7–8 (25–26):199–216 (Hebrew; English summary, p. 19*).
- Magen, Y. 1993. Qedumim—A Samaritan Site of the Roman-Byzantine Period. In *Early Christianity in Context: Monuments and Documents*, ed. F. Manns and E. Alliata, 167–80. Studium Biblicum Franciscanum Collectio Maior 38. Jerusalem: Franciscan Printing Press.
- Magen, Y. 2008. Oil Production in the Land of Israel in the Early Islamic Period. In *Judea and Samaria: Researches and Discoveries*, 257–343. Translated by E. Levin and M. Guggenheimer, from Hebrew. Judea and Samaria Publications 6. Jerusalem: Staff Officer of Archaeology, Civil Administration for Judea and Samaria/Israel Antiquities Authority.
- Marshall, C. 1992. *Warfare in the Latin East, 1192–1291*. Cambridge Studies in Medieval Life and Thought, 4th ser., 17. Cambridge: Cambridge University Press.
- Mason, R. B. 1997. Medieval Egyptian Lustre-Painted and Associated Wares: Typology in a Multidisciplinary Study. *Journal of the American Research Center in Egypt* 34:201–42.
- Matson, G. E. 1980. *The Middle East in Pictures*. 4 vols. New York: Arno.
- Minville Larousse, N., and M.-C. Bailly-Maitre. 2011. Ore Grinding in the Middle Ages: The Example of Brandes-en-Oisans (Isère, France). In *Bread for the People: The Archaeology of Mills and Milling; Proceedings of a Colloquium Held in the British School at Rome, 4th–7th November 2009*, ed. D. Williams and D. Peacock, 217–30. BAR International Series 2274; University of Southampton Series in Archaeology 3. Oxford: Archaeopress.
- Peled, A. 1999. The Local Sugar Industry under the Latin Kingdom. In *Knights of the Holy Land: The Crusader Kingdom of Jerusalem*, ed. S. Rozenberg, 251–57. Jerusalem: Israel Museum.
- Perkins, A. 1951. Archaeological News: The Near East. *American Journal of Archaeology* 55:81–100.
- Porat, L., R. Frankel, and N. Getzov. 2012. The Lever Presses of Eretz Israel in the Light of the Alone Abba Oil Press. *'Atiqot* 70:51–81 (Hebrew; English summary, pp. 84*–86*).
- Poulsen, V. 1957. Les poteries. In *Hama, fouilles et recherches, 1931–1938*. Vol. 4, part 2: *Les verreries et poteries médiévales*, ed. P. J. Riis and V. Poulsen, 117–283. Nationalmuseets skrifter, Større beretninger 3. Copenhagen: Kommission hos Nationalmuseet.
- Prawer, J. 1972. *The Latin Kingdom of Jerusalem: European Colonialism in the Middle Ages*. London: Weidenfeld and Nicolson.
- Pringle, D. 1992. Aqua Bella: The Interpretation of a Crusader Courtyard Building. In *The Horns of Hattin*, ed. B. Z. Kedar, 147–67. Jerusalem: Yad Ben-Zvi/Israel Exploration Society; London: Variorum.
- Pringle, D. 1997. *Secular Buildings in the Crusader Kingdom of Jerusalem: An Archaeological Gazetteer*. Cambridge: Cambridge University Press.
- Pringle, D. 2000. *Fortification and Settlement in Crusader Palestine*. Variorum Collected Studies Series CS 675. Aldershot: Variorum.
- Pringle, D. 2012. *Pilgrimage to Jerusalem and the Holy Land, 1187–1291*. Crusade Texts in Translation. Burlington, VT: Ashgate.
- Riley-Smith, J. 2012. *The Knights Hospitaller in the Levant, c.1070–1309*. Houndmills: Palgrave Macmillan.
- Roll, I. 1999. Introduction: History of the Site, Its Research and Excavations. In *The Persian and Hellenistic Periods (with Appendices on the Chalcolithic and Iron Age II Remains)*. Vol. 1 of *Apollonia-Arsuf: Final Report of the Excavations*, ed. I. Roll and O. Tal, 1–62. Sonia and Marco Nadler Institute of Archaeology Monograph Series 16. Tel Aviv: Emery and Claire Yass Publications in Archaeology.
- Roll, I., and E. Ayalon. 1989. *Apollonia and Southern Sharon: Model of a Coastal City and Its Hinterland*. Tel Aviv: Hakibbutz Hameuchad/Israel Exploration Society (Hebrew; English summary).
- Runciman, S. 1954. *The Kingdom of Acre and the Later Crusades*. Vol. 3 of *A History of the Crusades*. Cambridge: Cambridge University Press.

- Runnels, C. 1990. Rotary Querns in Greece. *Journal of Roman Archaeology* 3:147–54.
- Saller, S. J. 1946. *Discoveries at St. John's, 'Ein Karim, 1941–1942*. Publications of the Studium Biblicum Franciscanum 3. Jerusalem: Franciscan Press.
- Saller, S. J. 1957. *Excavations at Bethany (1949–1953)*. Publications of the Studium Biblicum Franciscanum 12. Jerusalem: Franciscan Press.
- Seligman, J. 2006. Jerusalem, Khirbat Ka'kul (Pisgat Ze'ev H): Early Roman Farmsteads and a Medieval Village. *'Atiqot* 54:1–73.
- Shaked, I. 2000. Identifying the Medieval Flour Mills at Doq and Recordane. *Cathedra* 98:61–72 (Hebrew; English summary, p. 172).
- Shenhav, E. 2009. A Byzantine Oil Press at Shuni. In *Oil and Wine Presses in Israel from the Hellenistic, Roman and Byzantine Periods*, ed. E. Ayalon, R. Frankel, and A. Kloner, 143–48. BAR International Series 1972. Oxford: Archaeopress.
- Stern, E. 1994. *Dor, Ruler of the Seas: Twelve Years of Excavations at the Israelite-Phoenician Harbor Town on the Carmel Coast*. Jerusalem: Israel Exploration Society.
- Stern, E. J. 2012a. Mi'ilya: Evidence of an Early Crusader Settlement. *'Atiqot* 70:63*–76*.
- Stern, E. J. 2012b. *Akko I, The 1991–1998 Excavations: The Crusader-Period Pottery*. 2 vols. IAA Reports 51. Jerusalem: Israel Antiquities Authority.
- Stern, E. J., and A. Tatcher. 2009. The Early Islamic, Crusader and Mamluk Pottery. In *The Late Periods*. Vol. 2 of *Ḥorbat 'Uza—The 1991 Excavations*, ed. N. Getzov, D. Avshalom-Gorni, Y. Gorin-Rosen, E. J. Stern, D. Sion, and A. Tatcher, 118–75. IAA Reports 42. Jerusalem: Israel Antiquities Authority.
- Tal, O., and I. Roll. 2011. Arsuf: The Site, Settlement and Crusader Castle, and the Material Manifestation of Their Destruction. In *The Last Supper at Apollonia: The Final Days of the Crusader Castle in Herzliya*, ed. O. Tal, [8]–[51]. Tel Aviv: Eretz Israel Museum.
- Tal, O., and I. Taxel. 2008. Ramla (South): An Early Islamic Industrial Site and Remains of Previous Periods. *Salvage Excavation Reports* 5.
- Thorau, P. 1995. *The Lion of Egypt: Sultan Baybars I and the Near East in the Thirteenth Century*. Translated by P. M. Holt, from German. London: Longman.
- Tsioni, G. 2010. A Mameluke Grape-Honey Treading Installation in the Golan Heights, Israel. *Israel Exploration Journal* 60:222–44.
- Yehuda, E. 2007. Khirbet al-Khurrumiya: A Fatimid Farmhouse in Northern Israel. *Salvage Excavation Reports* 4:139–54.
- Yehuda, E. 2010. *Household Archaeology: The Case of Pottery and Rural Dwellings during the Crusader Period*. PhD diss., University of Haifa.
- Yehuda, L. 2011. Cooking and Food in the Latin Kingdom of Jerusalem. In *The Last Supper at Apollonia: The Final Days of the Crusader Castle in Herzliya*, ed. O. Tal, [52]–[61]. Tel Aviv: Eretz Israel Museum.