WHAT DID JERUSALEM'S FIRST-CENTURY BCE GLASS WORKSHOP PRODUCE?

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The assemblage of glass fragments discussed here was uncovered in the Old City of Jerusalem, in the centre of the Jewish Quarter, which in the Early Roman period was a well-to-do neighbourhood called the 'Upper City' (Avigad 1983, 186–92). The excavations, which took place in the early 1970s, were directed by Professor Nahman Avigad on behalf of the Institute of Archaeology of the Hebrew University of Jerusalem.

The assemblage was found in a disused ritual bath (miqva'ah) that was intentionally filled with refuse. The bath was sealed by a road built during the reign of King Herod (37–4 BCE), or shortly thereafter. The pottery and the many coins found in the debris date the filling of the ritual bath to the first half or middle of the 1st century BCE.

Several hundred glass fragments were found concentrated in a layer of the fill, which consisted mainly of organic matter. Professor Avigad assumed that the glass assemblage was manufacturing waste from a nearby workshop, that had been dumped into the ritual bath after it had gone out of use. Indeed, careful sorting of the material showed remarkable homogeneity of all the finds, which seem to originate from a single location.

The finds can be grouped as follows: mould-made bowls, applicators or stirring rods, tiny blown bottles, inlays, whorls and gaming pieces, and flat glass sheets. Much of the material consists of manufacturing waste, the exact character of which is hard to ascertain. This assemblage from Jerusalem attests to the existence of a Hellenistic workshop. This is a significant addition to the few such known ones (Weinberg 1971; Nenna 1999, 159–68). The fragments provide evidence for three glassworking techniques — casting, blowing and tooling — all presumably in one workshop. Some of the products such as the cast bowls are quite common; others are very rare or even unique. The most important feature of the assemblage is the evidence it provides for the blowing of glass vessels from glass tubes, found here for the first time. This evidence may explain how glassblowing was discovered — the wondrous technique that made glass one of the most common materials.

SAGGED (SLUMPED) BOWLS

The group of bowls includes 120–30 items, mostly conical bowls and hemispheric ones with grooves inside, and a few more elaborate types. All are well known from the repertoire of sagged bowls in Hellenistic sites throughout the Eastern Mediterranean (Grose 1989, 193–4). However, in contrast to other large assemblages, in Jerusalem there were only a few fragments of fluted bowls and of bowls decorated with cut leaves. Only one tiny fragment of a ribbed bowl was found. Many base fragments survived, almost all showing remains of superficially abraded circles on the outside, most of them with tiny circles in the centre. Apparently, the majority of the bowls had such marks which may have resulted from the pressure of the stand on which the bowl was held while being polished or engraved. It is hard to single out manufacturing waste of the bowls: some fragments are deformed, but this could be due to damage caused by excessive heat, after the object had been finished.

Most of the bowls are colourless, sometimes with a yellow or greenish-bluish tinge, several are greenish of various hues, and a few are of the strong yellow-brown (amber) colour. Comparisons with the groups of Hellenistic cast bowls found in the Eastern Mediterranean as at Delos (Nenna 1999, 66–7) and Anafa (Weinberg 1970, 19–21) are limited because of the small number of fragments from the Jerusalem workshop. Still the relation between the types — the number of conical bowls exceeding that of the hemispherical ones — is the same in these three sites, whereas the proportions of the colours is different. In Anafa and Delos strongly coloured bowls dominate, while in the Jerusalem workshop the colourless are the absolute majority. The group of bowls found in the Souks of Beirut comprises more hemispherical than conical bowls (Jennings 2000, 45).

APPLICATORS OR STIRRING RODS

Two types of objects belong to this group: a) smooth rods with both ends rounded (FIG. 1); b) twisted rods with one edge rounded and the other pointed (FIG. 2). Of the first type, a few were found complete — their length varies from 95 to 145mm; one is purple, and all the others are colourless. The total length of the many fragments of smooth rods, 40mm long and more, is about 30mm. Published examples of this type of rods are rare (Ariel 1990, 159, fig. 31.GL60; Spaer 2001, 264 no. 236, pl. 49).

No twisted rod was found complete. There were many fragments with rounded ends and a few with pointed ones. Their length when complete was probably similar to that of the smooth rods. The fragments preserved are up to 90mm long. The total length of the twisted rods fragments may be more than 5m. Most of the twisted fragments are
colourless, but there is also one purple, one brown, one yellow, and two blue ones, and several of two colours, with a white thread wound around the colourless rod. The remains of production stages are easy to identify – ends of rods with the impressions of the tongs by which they were held, pulled and twisted. The twisted rods seem to be of an earlier type than the known Roman ones, with one end formed like a flattened disc and the other decorated with an attached bird or a tiny jar, or shaped like a ring (Spaer 2001, 262, pl. 49.631–2).

**Blown Bottles (Fig. 3)**

The most important and unique finds in the Jerusalem workshop were the remains of glassblowing that suggested that glass was blown directly from glass tubes – most likely an early stage of glassblowing (proto-blowing) before the use of a metal blow-pipe. A preliminary description of the remains of tube blowing in the workshop was published a few years ago (Israeli 1991). Strips of glass were folded to form glass tubes; these were then drawn, having a squeezed shape at their ends and becoming rounder further from the edges. After trimming of its ends, the tube was pressed closed on one end, and inflated to the shape of a small bulb which formed the oval body of the bottle. Part of the tube above the bulb formed the neck of the bottle, and the rim was shaped and out-turned at the top of the neck. Wasters from all the production stages were found in the assemblage, leaving no doubt that they were locally produced. One bottle, of yellowish glass with wound white thread, was found entire but collapsed (Fig. 4). Altogether ten necks with finished rims were found, these being the last parts to be shaped in the formation sequence of the vessel; they may be considered parts of finished bottles. The colours are hard to define because of the heavy weathering, but it seems that about half of the bottles had wound threads in contrasting colours.

Fragments of tubes, the raw material for the blowing process in the Jerusalem workshop, were found in various sizes and in considerable number. Many are very thin, probably the end parts of the drawing operation. They seem

**Fig. 4 A finished bottle that sagged after production**
to have been made mostly from colourless glass and naturally coloured glass, but the blue and the yellow brown seem to be more in evidence among the tubes than in the other groups. Conceivably all the tubes from the workshop were produced for the production of blown bottles. To the best of my knowledge, no other occurrence of glass tube-blowing is known from that period (Whitehouse 1997, 142, no. 236; Crowfoot 1957, 420).

**WHORLS, BEADS, INLAYS AND GAME-PIECES (FIG. 5)**

This group consists of several artefacts, all made by policing or moulding. Their functions are not always clear; similar ones have been found in excavations, and a few unprovenanced ones exist in collections. Very few examples of each were found, including: ten colourless and greenish whorls – 15 to 40mm in diameter (Nenna 1999, 135–6, pl. 55.E115–E121); seven small flat beads of indeterminate colour, some probably white 10 to 27mm in diameter (Nenna 1999, 135, pl. 55.E110–E114); six flat inlay pieces – triangular, rhomboid, and round plaques are of opaque white and light blue glass in addition to transparent or translucent colourless glass (Weinberg 1971, pl. 80c; Nenna 1999, 154, pl. 55.E271; Christie’s 1999, lot 243). In this context we may consider the possibility of using fragments of twisted rods as inlays, like the wall pavement from Rome in the Corning Museum Collection (Goldstein 1979, 263–4, no. 791, pl. 35). Other inlays for jewellery or game-pieces are round to oval, convex in section. These simple objects are very common and have been found in hundreds in excavations, but only eight were found in the Jerusalem workshop. Most are colourless, one is greenish, and one yellow (e.g. Crowfoot 1957, 392, fig. 92.86–7; Weinberg 1971, pl. 80b; Ariel 1990, 157, fig. 31.GL37–GL40; Spier 2001, 233, pl. 41:548). Seven conical pieces, 15–10mm high and 8–13mm in diameter, some with a vertical hole, could also be parts of jewellery or game pieces. Three puzzling objects – 40mm high thick rectangles with a rounded top and a large hole – may be weights of some sort. One is bluish-green and two are yellow.

Identifiable wasters(?) of this group are a few inlays fused together, and perhaps some of the flat and composite strips.

**FLAT SHEETS (FIG. 6, RIGHT)**

Few colourless flat fragments were found, the largest 100mm long. Some have straight edges and rounded corners, which may indicate that the complete panes were rectangular. Could they have been used as window panes? Or they may have been used as inlays. Gladys Weinberg in her article on the Rhodes bead workshop suggested that the flat fragments were intended to be saggared to make bowls (Weinberg 1971, 147–8).

**PRODUCTION WASTE AND RAW MATERIAL (FIG. 6)**

Only a few fragments look like splinters from chunks of raw glass. More seem to be wasters from the manipulation of the glass during manufacture – drops, small lumps, drippings, etc.

**THE COLOURS OF THE GLASS (COLOUR PLATE 13)**

The glass from the Jerusalem workshop is heavily corroded and covered with a thick weathering crust; the thickness of the glass, therefore, could not be measured. Sometimes the glass itself is no more, and the weathered layer is all that has kept the shape of the artefact. Because of the weathering it is hard to determine the colours, but it seems that most of the usual colour common in glass of the Hellenistic period are represented in the lot. As mentioned above, most of the glass is colourless, sometimes with greenish, bluish or yellowish tinges. Light hues of yellow, green and blue exist as well. The strong colours are yellow brown (amber), blue, and purple. All these are transparent or translucent. A few opaque red, white and light blue glass pieces are also extant, but in small quantities.

To date, some 40 samples have been analysed by energy dispersive X-ray analysis in the scanning electron microscope (SEM-EDX), all of them proved to be of the typical soda-lime-silica type (preliminary unpublished report). According to Dr Ian Freestone, the yellow brown is due to a complex of iron and sulphur (ferro-sulphide
chromophore), which is formed in the glassmaking furnace under highly reduced conditions and is a natural colour of the glass. This may explain the frequent occurrence of yellow-brown glass in Late Hellenistic bowls. The colourless glass was obtained by adding manganese oxide to the batch. The purple glass was obtained by the manganese in oxidized conditions, either intentionally or by chance. The blue was obtained by adding cobalt. According to Dr Freestone, these colours form fairly tight groupings and probably correspond to single batches of glass or campaigns of melting.

Some of the major elements divide the material into two groups, differing in their lime and alumina content. The two groups also differ in chlorine content. This implies that they were made from different sands and alkali and under different conditions—either the glass was created by two separate firings of the furnace, with raw materials brought from different sources, or it came from different workshops of raw glass production. Comparison of alumina content in colourless bowls with other colourless artefacts shows that different batches were used for making them. In the yellow-brown group, on the other hand, the bowl (only one was analyzed) and the other products seem to have been made from the same batch.

To sum up, in Ian Freestone’s words:

In general, the workshop waste and working pieces are of the same composition as the objects. The different colours are not widely separated, but occur in the same general groupings, which seem to indicate that the transparent colours were made in this workshop by adding manganese and/or cobalt (I. Freestone pers. comm.)

The tight groupings of the colours also show that only a limited number of glass batches were used in the workshop, suggesting a short period of production.

In conclusion, at this stage it seems that the products mentioned were locally manufactured in the Jerusalem workshop. Future research may provide fuller understanding of the remains, and offer more insights into the character of secondary glass workshops in the late Hellenistic period.

ACKNOWLEDGEMENTS

I am grateful to Hillel Geva, who is responsible for the publication of the excavation results, for letting me work on the finds. The research is still in its early stage, and the conclusions presented here should be considered preliminary. The final report will be published in the series "Jewish Quarter Excavations in the Old City of Jerusalem conducted by Nahman Avigad, 1969–1982,” issued by the Israel Exploration Society and the Institute of Archaeology, Hebrew University of Jerusalem. (The first and second volumes appeared in 2000 and 2003.)

The processing of the finds was done in collaboration with Natalya Katsnelson, Associate Curator in charge of the ancient glass collection in the Israel Museum, Jerusalem. The photographs were prepared by Peter Lanyi, Fig. 4 was taken by Mariana Salzberger.

Dr Ian Freestone, then Deputy Keeper of the Department of Conservation and Science in the British Museum, kindly agreed to conduct the scientific analyses and interpretation of the material.

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