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Shards for Beads ?

by Tine Gam Aschenbrenner

Shards of blown vessel glass found in Scandinavian settlement contexts can be interpreted in several ways. Do the pieces mirror an assemblange of whole, unbroken glass vessels brought to the site? Or should they be seen as cullet imported for a local glass bead production? Is it at all possible to produce beads from broken vessel fragments? In the light of archaeo-experiments these questions are discussed below.

INTRODUCTION

A glass vessel found in a grave is ... a glass vessel; and if only a single fragment is discovered, a *pars pro toto* interpretation is often suggested. A simple explanation to a simple phenomenon. When a number of fragments from the same beaker or vessel are found at a settlement site, even within the same house, it is usually assumed that these fragments represent a whole beaker broken due to unfortunate circumstances. One examble is the house from Dejbjerg, which probably contained a minimum 15 beakers, mainly found in the central and eastern part of the house (Egeberg Hansen 1996, 228). Another example is the glass finds from house I at Borg, Northern Norway, dated to the later half of the the first millennium AD (Henderson & Holand 1992). Despite the fact that the fragments from Borg did not come from a closed find such as Dejbjerg (the Dejbjerg house had burnt down), a number of fragments from the same beaker, supported by an analysis of the batch composition, made it possible to establish the grouping of the glass vessels from Borg. This was interpreted to indicate that the vessels had been imported as complete items (Henderson & Holand 1992, 33).

In more datable settlement contexts such obvious explanations do not always account for the glass fragments found. Sorte Muld on Bornholm is one such example. In 1986 and 1987 excavations on this site uncovered 267 hollowware glass fragments, and a large number of beads. The most famous finds from the site must be the 2300 gold foil figures, but also traces of different crafts (such as iron, bronze, gold and amber working) should be mentioned. The glass fragments have been interpreted as possible raw material for bead making (Watt 1991, 100), although Margrethe Watt also points to the possibility that they represent luxury trading goods. However, in a later reference to the find, it is again suggested that the fragments could possibly be viewed as raw material (Jensen & Watt 1993, 198). As a permanent settlement for several centuries and because of the rich finds uncovered there, Sorte Muld has been characterized as a central place (Watt 1991).

Why has glass bead making been suggested, despite the fact that no production waste or other indications of the craft have been found at Sorte Muld? Part of the answer is found in the trade and exchange connections of which Sorte Muld have similarities with other Scandinavian market places. Another part of the answer may be found at sites with strong evidence that bead making took place. To what extent bead manufacture can be assumed at Sorte Muld will be discussed later in this paper.

When characterizing a location as a market, trading center, or an ordinary habitation site, it is impor-

tant to establish to what degree glass fragments from broken, blown hollow-ware can be regarded as an indication of local bead production. The difference between mere trading with goods and the actual production of them is crucial for the understanding of the activities in and around a settlement. As with crafts the presence of the finished goods is in itself no evidence for a local production, no matter how many items are found. Even if two different find categories are identified it does not follow that manufacturing took place, but somehow the phrase 'bead making' often pops up when glass beads and vessel fragments are found at the same site.

The focus here is on the category "raw materials", as glass shards almost inevitably are regarded as raw material for glass beads. Vera I. Evison has summed it up thus: "....the use of glass fragments to melt down into small baubles like beads is, of course, a possibility on any site" (Evison 1982, 53). It was to test this possibility that the experiment described below was carried out.

BEADFORMING TECHNIQUES

The type of bead most frequently found in Scandinavia in the 8th and 9th centuries is the "wound" bead. It was made by winding hot glass around a solid core. The technique has been the object for archaeoexperiments (Gam Aschenbrenner 1997 with references) and a few of the main results are listed because they lay the foundation for the actual experiment.

- First of all, it turns out that crucibles for bead making consume too much glass and fuel.
- Secondly, it has been stated that crucibles are necessary for the bead-making process. But if we assume the use of crucibles, we should expect them to show up in greater numbers, especially at sites with many craft identifying artifacts. In reality, only very few crucible fragments have been found.
- Finally, the development of an alternative method for making beads without crucibles seems very convincing, the so-called "fragment gathering method".

A few more words about crucibles

For the interpretation and understanding of glass fragments as raw material for beadmaking it makes a difference whether the use of the crucible or the fragment gathering method is presumed. The indirect heating of glass in a crucible leads to a considerable fuel consumption, compared with directly heated glass, when the fragment gathering method is used. The advantage of using a crucible is that the glass can be cleared of embedded air bubbles by heating it for some time, but this will inevitably imply an even higher fuel consumption. Furthermore, the crucible theory assumes that fragments were used as a basic glass to which tesserae could be added for colouring. The idea that only vessel fragments were used can be totally disregarded due to the discrepancy between the majority of transparent pale green(ish) vessel glass fragments and the often strongly coloured opaque beads.

Henderson & Warren have analysed an opaque yellow glass inside a crucible fragment from Ribe (1983). Compared with six other analyses of opaque yellow glass from Ribe (two of which were made on rods), the glass in the crucible fragment has a lower content of silica oxides, whereas the content of tin oxides is very much higher. Furthermore, this fragment does not derive from the beadmaker workshop layers (Näsman pers.comm.), making it more than questionable if it should be linked to the production of glass beads.

At the Funen site Lundeborg two fragments of crucibles "with fused glass on the inside" have been found (Thomsen 1995, 24), but an analysis of the exact batch composition from one of the fragments has shown that the content of copper, tin and zinc oxides makes it unlikely that the fragment should be linked to glass working (Thomsen forthcoming).

Outside Scandinavia we have a possible exception from York, where about 300 crucible sherds were found at 16-22 Coppergate and more than 1300 sherds at 22 Piccadilly, dated to the 11th century AD. The glass inside the crucibles was of a high-lead type with added copper to colour it green, like some beads from the site. One can hardly ignore the connection between beads and crucibles here, but an alternative interpretation is that the high-lead glass was primari-

ly for enameling, leaving the bead making as a minor activity. An interesting phenomenon is that "nearly 10% of the sherds [from the site] are not strictly parts of crucibles but are potsherds roughly chipped into discs about 50mms across. These have small pools of melted translucent blue glass on them, most of which has then been scraped off while still soft. There are drips and rods of similar glass as well as mis-shapen and complete beads, suggesting that blue glass fragments were being melted down and beads made from them" (Bayley 1997, 4). Unfortunately it is not specified what kind of blue fragments these were, but the manufacturing description is very close to the fragment gathering method. From the short note published it is difficult to discuss the finds in more detail here, but both methods could have been practiced, in parallel, at the same site. The geographical and chronological differences make it difficult to draw direct comparisons with the Scandinavian material.

As stated above, previous archaeoexperiments have stressed the fragment gathering method as the most likely for local bead production in Scandinavia. Only if future archaeological material should be enriched with a variety of crucible fragments – undoubtedly for bead making – will the archaeoexperimental results have to be reconsidered.

Original test glass

Using original archaeological material for a destructive experiment has been a way of gaining new knowledge before experimental archaeology was developed as a science. To test the bronze alloy from an English carnyx, found in 1768, the experimentator George Pearson "melted the old implements and cast them in the same ingot mould." (Coles 1979, 13). Fortunately this method was not generally accepted and almost all fields of experimental archaeology today use modern material. However, when an archaeological artifact is commonly found, and the total amount required for an experiment is tiny, we can ignore the importance of every single object. In this specific case it was also interesting to use the original glass compared with a glass replica, because of the difficulties in making an exact batch copy.

The working properties of glass differ according to glass type and to limit the experiment only one glass type was tested. Since the art of glass blowing was invented in the 1st century BC, a soda type glass was used. Caroline M. Jackson has recently published a study of the change from Roman to early medieval glasses, and an important result was that "while styles of glass change from the Roman into the early medieval period in Northern Europe, and visually the glass appears to deteriorate in quality and design, generally appearing to be technically less sophisticated, the composition appears to stay remarkably the same" (Jackson 1996, 291ff.)

During the 8th century AD the first signs of a shift from a high soda glass to a mixed alkali glass occur (Henderson & Holand 1992, 36). Therefore, an appropriate test material would be a soda glass from which it would be possible to use a small amount of approximately 200 g. Roman hollow-ware glass seemed to be an acceptable choice. The possibility arose to use glass from the excavation at Blake Street in York, which can be dated to 1st - 3rd century AD. The actual fragments derived from mouldblown bottles, which is the most common type of container found in Britain (Cool *et al.* 1995, 1580). They were broken into pieces measuring from 10 to approximately 80 mm in size, with an average thickness of 2 - 3 mm. Some base fragments reached a thickness of 6 mm. The colour was very pale greenish, sometimes with a bluish tinge. The quality seemed to be good, with very few seeds and bubbles. The glass composition was probably a soda glass, as is typical for Roman glass. An iridescent layer covered the fragments (Fig. 1).

It can be argued that Roman bottle glass is poorly suited to match the Scandinavian finds some 500 years later, as only very few bottles have been found in Scandinavia. These include a few smaller Frankish bottles, like the one from Hopperstad (Hougen 1968:101). Some are with trails, like the bottle from Stenum (Ekholm 1958, Abb.2), and additionally a few fragmentary larger pieces, like those from Dejbjerg (Egebjerg Hansen 1996, Fig. 10.4) have been found. From Herlufmagle, Zealand, we have an unbroken cylindrical mouldblown bottle from the 1st century AD (Lund Hansen 1973, Fig.5; 1979, Fig.1), but so far this bottle is unique and no (mouldblown) bottles of the Roman kind are known from Sweden or Norway.

From a practical viewpoint the differences between fragments from bottle glass and fragments from other vessel glass are in the shape and size of the fragments. The Roman bottles are mostly mouldblown straightsided, cylindrical, square or prismatic, with a rather thick base, which makes up a comparatively great part of the whole item. The vessel glass from Scandinavia consists of more or less conical beakers, bowls and cups and for these vessels the somewhat thicker base only make up a limited part of the whole glass. This means that the fragments for the experiment had a somewhat greater thickness, than if Frankish glass fragments had been used. Another factor which should be taken into account is that thicker fragments tend to withstand breakage, but on the other hand they were more likely to be retrieved, thereby not appearing in the archaeological register. This compares with smaller and thinner pieces, which break easily, and then into small bits which may disappear into the soil and subsequently be excavated.

THE EXPERIMENT

Finds from the 8th century workshop layers in Ribe, Denmark (Näsman 1979), formed the basis for the test workshop conditions. The bead making process was carried out using a small open fireplace with an inner diameter of c. 40-50 cm, and a pair of bellows to raise the temperature. Charcoal was used as fuel. The tools consisted of a gathering iron (solid iron rod), bead mandrels, a pair of metal tongs, a pair of wooden tongs with grips of antler, a knife, an iron pan, and an iron tong.

To prepare the fragments the white ink museum numbers were removed with spirit and rinsed off with water. The fragments were then placed for pre-heating on the iron pan near the heat centre in the fireplace. The gathering iron was heated until yellowish orange in colour, after which a tiny fragment of glass could be melted onto the gathering iron. Having heated this fragment to the melting point it was easy to gather a greater fragment, and heat it until melting, and then gather a new fragment ... and so on, until it was possible to make beads from the lump of molten glass achieved. Only the most simple kinds of beads were made, plain globular and melon beads.

Fig. 1. Roman bottle glass fragments (Blake St., York, 1st-3rd c.AD) and beads made from the fragments. Photo: M. Schreiner, ALM.

After each bead had been made it was carefully placed in a jar filled with ashes. The jar stood inside the fireplace, but opposite the heat centre. Within an hour the temperature in the jar rose from 150° C to 550° C which was regarded as an acceptable upper temperature for the following annealing period. After the last bead had been made, the fireplace was left to cool down over night, and some red-hot charcoal was arranged around it to ensure that cooling did not happen too quickly.

Results

All the beads turned out to contain a large amount of bubbles, and many also had some darker streaks. The bubbles often burst during production leaving big scars in the surface of the beads (Fig. 2); or causing a very uneven annealing of the beads, i.e. they broke easily.

Three possible sources for the bubbles can be listed:

- Glass quality.
- Air trapping during melting process.
- Iridescent surface.

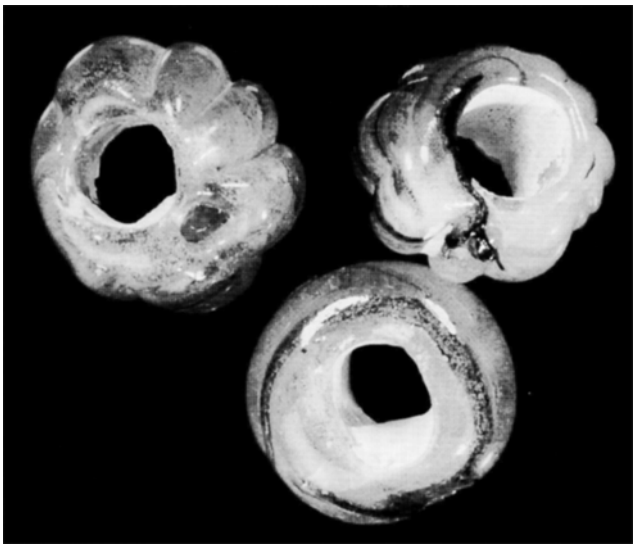

Fig. 2. Replica beads made from Roman bottle glass fragments. Photo: M. Schreiner, ALM.

A common characteristic of all ancient glass is the presence of bubbles, or glass seeds, which appear in many different sizes and numbers according to the glass quality. For most blown items the seeds only form an aesthetic problem, but for the beadmaking process they are also a physical problem, as the amount of glass for each bead is much less, and so the glass seeds expand more easily when heated, leading to bursting bubbles and eventually scars. As mentioned before, the Roman glass used for the experiments contained very few seeds, but occasionally larger bubbles, and both led to bursting bubbles. It is worth noticing, that Frankish and Carolingian glass generally contains more bubbles, than Roman glass, i.e. beads made from a such poor quality fragments would contain great amounts of bubbles or scars.

That air became trapped happened because a hollow ware (body) glass fragment has a rather large surface area to volume ration and when turning the mass into a more massive lump of molten glass the fragment will fold down in various ways. Depending on the size and shape of the fragments it is almost inevitable that air will become trapped in the foldings. At least, this was what happened during the test, causing some very large bubbles.

The iridescence is the result of devitrification, where the alkaline has been washed out causing a laminated surface. The darker streaks of 'polluted' glass, which can be seen on some of the beads probably derive from the lamination, but this need to be verified. Additionally it has to be checked to what extent the streaks only formed an aesthetic problem, or if they also caused uneven annealing. It is worth noticing that for this experiment the fragments were approximately 1700 years old, so a similar problem probably did not arise for the bead makers in for instance Ribe, unless it could be proved that they used fragments which were about 500 years old, and that such an iridescence was present at the time.

The inevitable conclusion

It is difficult to estimate to what exact degree the three categories of possible problems listed above have influenced the beads. The only category which is dependant on the craftman's skills is the folding process. The result from this experiment would probably turn out slightly differently with more experience, but this will not eliminate the fact that glass with a rather large surface area to volume ratio forms a bad raw material for bead making, when the fragment gathering method is used.

The inevitable conclusion must be, that hollow ware glass fragments form a rather inconvenient basis for glass bead making. It is possible, but using the fragment gathering method, the result will turn out to be somewhat poor. Ulf Näsman has put it in a nutshell when writing that: "...that some [glass] fragments were probably remelted in the bead making workshops, but for bead making there were better raw materials like tesserae and raw glass" (Näsman 1984, 36). The following example shows the accuracy of the description.

Fragment-made beads? Ribe, once again

A curious fact is that fragments so often are interpreted as a raw material, but only seldom has that argumentation been put forward in the light of the beads themselves. Few beads or other glass items are described as being made from fragments. Ulf Näsman

mentions a bronze pendant with a mounted piece of yellow glass, covered of a layer of opaque reddish brown glass from the settlement fort Eketorp II, Öland (Näsman 1984, 24). A poorly formed spindle-whorl made of transparent green glass derives from Treby, Segerstad, Öland (Näsman 1984, 24). From a grave at Dømmesmoen, East Agder, Norway, comes a yellow and blue glass bead which has been interpreted as being made from a fragment of a cased glass (*Überfangglas*) (UOT, 1982:66-72, Fig.11).

Ribe, too, seems to provide a relevant example, represented by some beads from one of the workshop layers (layer A 330) at "Posthusfeltet", dated to AD 740 - 770. The possibility that these beads were imported is disregarded here. The beads (ASR X 513) were made from bluish green glass (two with yellowish streaks) as simple wound beads without any decoration. The glass quality is very bad with numerous bubbles, some scars and grains of sand melted into the surface (Fig. 3). Lene Lund Feveile has suggested that they were made from fragments; possibly from polychrome fragments with cable decoration, judging from the two beads with yellow streaks (Lund 1993, 54, note 156). Indeed, the test beads and the Ribe beads share the same characteristics: many bubbles and contaminated glass. Both must be regarded as low quality products. Taking the colour(s) as an indicator, it would also be reasonable to regard the beads as a local product made from hollow-ware fragments, as the dominant colour for the hollow-ware fragments found in Ribe is bluish green.

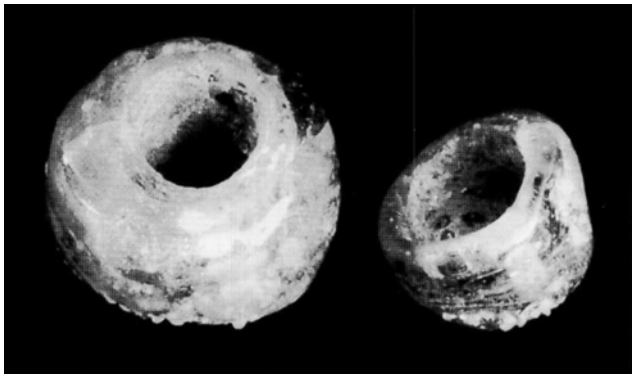

Fig. 3. Beads made from hollow-ware glass fragments? (ASR X513, Posthusfeltet, Ribe, 8th c. AD). The large bead measures 11 mm. Photo: M. Schreiner, ALM.

APPROPRIATE RAW MATERIAL

What, then, is the optimal form of the raw material ? The answer lies indirectly in what was said above. The ideal form is cubic with a side length of about 10-15 mm.

This brings us to the mosaics or tesserae. These little dices, in many colours, have been found almost exclusively at sites with other indicators of the bead making craft, and are themselves taken as an indicator of the craft (e.g. Näsman 1979, 127; A. Lundström 1976, 5 with references). In Ribe they have been found in their thousands and the correspondence between the colour of the mosaics and the beads makes it more than probable that the mosaics acted as a raw material in the bead production. This pattern is partly paralleled by the glass finds from Paviken, Helgö, Åhus and Kaupang.

The other raw material is "raw glass", characterized as non-blown glass, i.e. with arbitrary form and thickness, and possibly containing air bubbles with no clearly direction. The finds from Ribe leave the impression that the bead makers were not short of raw materials. In Åhus, cobalt blue raw glass made up 48% of the total glass finds (Callmer 1982, 224). This cobalt blue colour is very typical of many of the plain globular beads, melon beads and rod-band decorated beads at both sites. Likewise, a certain amount of white raw glass from Ribe can be paralleled in a selection of white beads. The presence of small splinters of blue raw glass could indicate that the raw glass was imported in a form (as cakes ?), which was awkward to handle for the bead making process, and which required breaking up. Näsman has expressed this idea for the Ribe glass (Näsman 1979, 128), and concerning the raw glass from Åhus Johann Callmer writes that "many, if not all [raw glass], have been struck from rounded glass cakes...not unlike the round glass smoothstones.." (Callmer & Henderson 199, 2). The breaking-up process could also be supported by the experiments, which made it clear that there is an upper limit for the size of the raw material. This limit is closely connected to the size of the heat centre, i.e. larger pieces of raw glass demand a larger heat cen-

tre to melt, which again leads to a greater fuel consumption. It would seem only logical that the bead makers in Ribe and Åhus also had an economic work attitude.

Supply and trade

Within Scandinavia there is not much to add to the impression of itinerant beadmakers bringing with them the necessities of the craft. However, an exclusive trade in tesserae could have supplied not only this activity, but also the related work of enamelling. Still, it is difficult to estimate to what degree the makers and their material were separated. A short digression to the widespread Roman transport system shows that it was no problem to move even greater amounts of raw glass, as long as the transport route was water. We get an impression of the actual volume from those ancient misfortunes which are so beneficial to the archaeologists. A shipwreck from the 1st century AD found at Mljet on the Croatian coast has been investigated, and among the commodities were 100 kg of bluish green raw glass, in lumps. As there were no traces of containers, the authors believe that the glass was packed in organic material (Radic & Jurišic 1993, 113). In the Mellieha Bay on Malta, some lumps of brown glass and blue pellets of frit from a shipwreck can be dated to the 3rd century AD. The excavator suggested that the brown glass was transported to be cut as tesserae (Frost 1969, 13). Further east, along the present Israeli coast, several Roman wrecks or cargoes, dated between the 1st and the 3rd century AD, have been located, some of which contained raw glass, either as "blocks of crude yellow glass" or as "broken ingots of glass" (Galili *et al.* 1993, 71). Almost a millennium later a ship capsized at Serçe Limani, in present day Turkey. The cargo of raw glass weighed almost 2 tonnes. In addition there was a huge quantity of blown glass waste fragments – around 1 tonne (Bass 1984, 64; Lledó 1996, 9ff.).

From these few examples it is obvious that within the Mediterranean blown glass producing area raw glass was a well-known commodity. Additionally, the finds from Serçe Limani show that waste glass definitely was a trade object.

Waste, cullet, scrap and fragments

Waste glass, in modern terms "cullet", can be broken hollow-ware, or workshop debris such as failed items, cut-offs from the blowing iron, drops and blobs – all kinds of finished glass. When raw materials for glass are melted together, a certain amount of cullet added to the batch will shorten the melting period. So, it makes sense to regard fragments as a valuable material which there would be no reason to export outside the blown glass producing areas. Therefore, it would be more precise to use the term "cullet" about glass fragments found in or near the glass producing zones, provided that they are not the poor remnant of a complete glass. Glass fragments found in Scandinavia should first of all be defined as ... fragments.

The transport has been referred to as "scrap-import", but the negative value of the word 'scrap' indicates a useless waste material, which was not the case, in either Scandinavia or further south on the Continent. A single glass fragment could be integrated into a ceramic vessel, adding to the value of the whole item. At the site of Lundergård, Northern Jutland, a green glass sherd was integrated into the bottom of a ceramic jar (Fig. 4) found in a grave from the 4th-5th century (Nilsson 1999)[1]. A similar piece has been found in a grave near Nørbæk in Central Jutland (Stidsing 1996, 118ff. Fig. 10)[2]. This 2 cm^2 greenish fragment is faceted and has been placed into the wet clay before the whole jar was fired. Such jars (*Fenstergefäße*) are known from a wide area of Northern Europe (Häßler 1993 with references). Glass fragments could also live a second life as beads or pendants. The most simple way to reuse glass fragment is to string it through a hollow part of the original vessel; for instance a hollow rim. This had happened

1. Vendsyssel Historiske Museum 26/1997, Lundergård, Jetsmark parish, Hvetbo district, Nordjyllands county. Grave no. A 13; the ceramic jar no. x 16. The grave has been excavated during summer 1997 by Torben Nilsson, Vendsyssel Historiske Museum.
2. Kulturhistorisk Museum Randers j.nr. 0807, "Ved Ålehøj", Nørbæk parish, Sønderlyng district, Viborg county. Grave no. A1. The jar is 9.4 cm high. The grave is dated to AD 250 - 320.

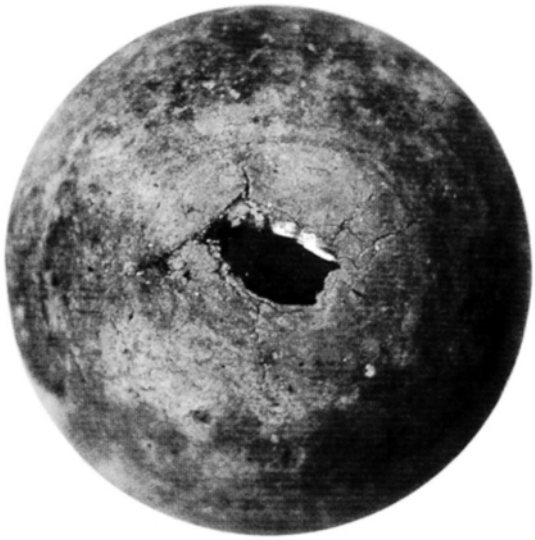

Fig. 4, Bottom of ceramic jar with green glass fragment inserted. (VHM 26/1997, Lundergård, 4th-5th c. AD)
Photo: T. Nilsson, VHM.

to the 'bead' from Slaum, Sweden. Another example is a 'bead' found at Brista, Sweden, which was in fact the middle part of a claw from a claw beaker. Drilling a hole through a glass shard would also be a method of stringing, as can be seen on a 'bead' from Tingvollheimen, Norway (Henricson 1995 with references).

SCANDINAVIAN BEAD MAKING SITES REVISITED

The discussion about the glass fragments, and their way to Scandinavia is first of all firmly connected to sites with a glass bead production. To elucidate the connection, or lack of connection, some well-known sites where bead manufacture generally is postulated are re-examined in the following.

The discussion is not new. In 1937 Holger Arbman expressed the idea, that hollow-ware fragments found in Haithabu should be seen as an import of scrap from the south (Arbman 1937, 68 note 2). Although the only firm 'evidence' for a local bead manufacture, the bottom of a furnace or fireplace (Schwantes 1932, 243), does not exist anymore, there are some production waste and semi-finished products in the glass finds which point to some kind of local work. However, the majority of the more than 7000 beads, together with all (at that time whole) vessels must be regarded as a natural import to this town-like site. In saying that it must be remembered that only a minor percentage of the area has been excavated, and therefore it would be no surprise if a bead workshop should come to light some day.

The far more ambiguous material from Helgö, with 1600 hollow ware fragments and 1100 beads (including items from burials) covering a period of about 800 years, is more difficult to interpret. Wilhelm Holmquist did not believe there was any scrap trade (Holmquist 1964, 259). Agneta Lundström has tried to elucidate all possible interpretations, where the glass finds are related to three different building groups and given alternative value according to the overall interpretation of the (function of) the houses. Her interesting result is that "in Building Group 3 the sherds may be considered to be raw material for bead making. In Building Group 2 they may be explained as broken vessels in ware houses. In Building Group 1 it is difficult to reach a decision as there is much which also shows it to be a beadmaking workshop" (P. Lundström 1981, 21). Concerning the chronological variation Lundström concludes that "complete vessels were imported during the Roman iron age whereas in the migration period/Vendel period the glass was brought in as raw material for the beadmaking workshops". This is perhaps too simplified a conclusion as one could ask why there should be a lacuna in the import of whole vessels, and Holmquist was probably more correct in his judgment. One of the most intriguing finds is still the bead stuck to the tip of an iron rod (A.Lundström 1976, Fig.2), a last greeting from an unlucky bead maker.

In his interpretation of the huge glass finds from Åhus Johan Callmer does not believe that the 856 glass shards should be associated with the bead manufacture (Callmer & Henderson 1991, 2). It would also seem superfluous, because of the overwhelming amount of cobalt blue raw glass at the site. According to the chorological and chronological similarities between Åhus and Ribe, it is tempting to imagine the same crew operating at both sites.

Concerning the glass from Kaupang, Ellen Karine Hougen supposed that the c. 250 vessel fragments

were (partly) imported as scrap, but she is cautious about the bead making material (Hougen 1969, 125). After a personal look through the material at Oldsaksamlingen in Oslo, I found strong indications that beads were made locally at Kaupang, – only not from fragments. Many blue and white beads compared with rods and tweezermarks in the same colours, green beads were mirrored in green waste material and more green and blue pieces have an iron (?) scaling, which could derive from the beadmaking iron.

About 80 vessel fragments were excavated at Paviken, together with 200 whole and misshapen beads, 39 tesserae, and c. 30 pieces of raw glass and bead production waste. The importation of scrap is suggested by the smallness of the shards (P. Lundström 1981, 97), but there is more congruity in colour between beads and some tesserae, raw glass and tweezer marks. The proposed bead mandrel from Paviken must be regarded as a mistake. It is hollow which must be seen as incompatible with bead making.

During the excavations in Birka the following categories have been found: a few tesserae, some lumps (raw glass?), and a few rods (Ambrosiani *et al.* 1974, 58). In her analysis of the glass from Birka, Greta Arwidsson suggested a connection between shards and beads and she also interpreted the fragments as scrap import (Arwidsson 1984, 210). Excavations carried out between 1987 and 1989 uncovered ten finds listed as waste from bead production: eight rods, one lump and one tweezer mark, and Lars Henricsson has pointed out that "this waste can be directly linked up with the bead material" (Henricson 1993, 146). However, I do not agree with Henricson "that native production using crushed glass vessels must be anticipated" (Henricson 1993, 146). During excavations in 1990 and 1991 in the Black Earth Area a lot of beads, a few tesserae, rods, raw glass and some fragments were found by water sieving. There were also signs of a division into lots, just as in Ribe (Ole Nielsen & Björn Ambrosiani pers.comm.).

Investigatinons have been carried out at Slöinge, Halland, since 1992 (Lundquist 1996; 1997 with refrences). The site has been designated as a chieftain's farm. Luxury goods and traces of specialized crafts were concentrated in the central room in the main building. The site has been partly excavated and some of the deposits watersieved. 69 glass shards, 86 beads (some misshapen), 3 tesserae and 225 pieces of bead making waste (rods, melted lumps, droplets, and tweezer marks) were found, and this material can be dated to the 8th century. One interesting fact is the presence of manufacturing within a building, the only other parallel being Helgö. Another is the great similarity with the bead material from Ribe. There is a striking resemblance concerning melon beads, polyedric beads with eyes, trail decorated beads (with a combed pattern), and mosaic beads from the two sites. The hollow-ware fragments should be regarded as what they are: fragments of glass vessels.

Herrebro in Östergötland was excavated in 1988 and 1989 and turned out to be a market place (Lindeblad & Nielsen 1992; Lindeblad 1996). Among other remains from different crafts were two mosaics, a few whole and misshapen beads, and some glass droplets. If the finds do not seem too convincing, it must be stressed that the excavated material is derived from the outermost part of the culture layer, which was not watersieved. More will very likely be found, – even fragments of blown glass.

Lundeborg on Funen represents the oldest site with c. 140 glass sherds, 360 beads, and 37 pieces of bead making debris (a few widespread rods, one tweezer-mark, and some lumps) all dated to the 3rd - 4th century AD (Thomsen 1995). In his examination of the finds Per O. Thomsen discussed the fragments as possible raw material for bead making. When it comes to the colours he stressed that this connexion is only supported by the beads to a certain degree: "Most of the glass sherds are greenish, while the majority of the beads are made of opaque, coloured glass. However, several beads with colours that correspond to the colour on the glass sherds are found at Lundeborg and in the cemeteries of the area" (Thomsen 1995, 23). Nevertheless, the crucial point is that the technical view is ignored. As a result it is immaterial whether the sherds originate from vessels broken on (the way to) the site, brought there as fragments, or collected there for redistribution.

Last, but not least and certainly not less numerous, are the hollow ware fragments from Ribe, more than 2000 fragments from several excavation campaigns, which also revealed different bead makers' workshops (Näsman 1979; Jensen 1991). The amount of hollow-ware fragments is not only the greatest

among the sites mentioned here, they also accumulated over a shorter period than, for instance, the approximate number from Helgö. A detailed publication of the glass is still awaited, but Lene Lund Feveile has based a thesis on the hollow-ware fragments from 'Posthusfeltet' (Lund 1993) and she also discusses the scrap import theories. Lund Feveile highlights the important fact that scrap glass could be reused in the glass-producing areas, leaving no reasons for export (Lund 1993, 54). This argument seems to have been ignored totally by other researchers, but its logic should not be underestimated. Per Lundström, for example, refers to Gregor of Tours as an example of a trade in cullet being documented in the written sources (Lundström 1981, 98), but he seems to overlook the fact that this trade took place within the glass producing areas.

That Ribe also revealed some beads which in all likelihood were made from fragments does not contradict this theory. On the contrary, taking into account the massive indications for beadmakers, operating in different places at the market, combined with the significant amount of hollow ware fragments at hand so to say, it is tempting to imagine how one beadmaker made use of an apparently suitable material, – and to imagine the dissatisfaction which followed. Certainly not a beau idéal to follow.

CRAFT IDENTIFICATION

The previously mentioned sites all share the common characteristic of being defined as market places with many indications of trade and exchange – some with a permanent settlement area. They could also be classified as central places, not necessarily in any value-laden respect, but simply because they grew up at localities which were central with regard to transport of people and commodities. Another common phenomenon is the remains of different crafts, which were carried out at these sites. This once again brings into focus the Bornholmian site of Sorte Muld, mentioned at the beginning of this paper, which has so much in common with these market places, resulting in the glass fragments being interpreted as a raw material for a, yet, unproven bead making activity. Indeed it would come as no surprise, if bead making was carried out at Sorte Muld, but glass fragments alone must not be taken as an indicator of the craft, no matter how many other non-bead-making similarities two sites may share.

The only way a local production can be rendered probable is by (a combination of, if not all) the categories:

1. Raw materials
2. Prefabrication
3. Production waste
4. Failed items
5. Tools
6. Other craft-identifying phenomena
7. Finished items

Applying these categories to the craft of glass bead making, the finds could be:

1. Raw glass or tesserae
2. E.g. polychrome twisted cables (reticella) or plates of mosaic for the two types of beads respectively.
3. Melted lumps or tool-marked pieces of glass
4. Failed beads
5. Bead making mandrel or a pair of tongs
6. Fireplace or furnace
7. Beads

What the actual archaeological remains really look like does of course depend on the kind of beads being produced including the technology used in the period in question.

CONCLUSION

From the outcome of the archaeoexperiment I would conclude that hollow-ware glass fragments form a bad raw material for glass beads. However, the possibility exists that fragments can be used, and bad quality beads from Ribe might be such an examble. So, from a bead maker's point of view, there would be no argument for importing glass fragments; – and since glass waste, or cullet, is almost a necessity in batch making, there would be no reason to export fragments from the glass producing areas. From this it must be evident that glass fragments found in Scandinavia are

first of all related to the trade or exchange in whole vessels. They all reached their final resting place as whole, unbroken, beautiful, fragile containers, unless they, regrettably, broke during transport. The logical consequence is that fragments are no indicator of a bead making activity. To identify the craft it would be more sensible to search for raw glass and tesserae, production waste, tools and working place debris.

Tine Gam Aschenbrenner
Zum Wald 6, Oberdorf
D-78465 Konstanz
e-mail: Aschenbrenners@t-online.de

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