



Figure 2.13 Flask of greenish glass with blue enamel-like weathering and flaking. On the body, three winding applied 'snake' coils, flattened and bearing a criss-cross design, ending in a triangular head. H 155 mm, D (rim) 30 mm, D (body) 81 mm. Late second century AD. Idalium, Cyprus. British Museum, London.

types of glass originally made in the East began to be produced in the West. Especially noteworthy are the two groups made from the second century onwards in the Rhenish centre of Cologne. One of these includes vessels with cut and engraved decoration. The other group bears the type of decoration known as *snake thread trailing* (Figure 2.13) which began to be made in Syria in the late second century and then, about 100 years later, appeared in a somewhat altered form in the Rhineland and in Britain (Figure 2.14); the western examples often bearing trailed decoration of a different colour from that of the body of the vessel (Harden, 1969).

Roman Gaul had a flourishing glass industry; some glass was already being made in Gaul before the influx of Sidonian and Alexandrian immigrants. One

of the Gallic factories made cylindrical bottles which were stamped on the base with the name *Frontinius* or its abbreviated form *FRON* (Figure 2.15).

In the third century, glass-making reached a peak, both in quantity and quality of products. During the third and fourth centuries Egypt also had a considerable blown glass industry which had not existed there previously. A large number of blown glass vessels with local stylistic features such as the fashioning of the bases, was found in the excavations at Karanis (Harden, 1936). It is interesting to note that the Emperor Aurelian (AD 270–275) had imposed a duty on Egyptian glass imported to Rome, presumably to offset its cheapness. The success of the



Figure 2.14 Flask of colourless glass, similar to that shown in Figure 2.13, but found in the Rhineland. H 213 mm. Third century AD. Cologne. Römisch-Germanisches Museum, Cologne.



Figure 2.15 A two-handed barrel-jug. The body is mould-blown with corrugations at the top and bottom. On the base is the moulded inscription *FRON*, an abbreviated form of *FRONTINIUS*. H 191 mm. Last quarter of the third century AD. Amiens, France. Ashmolean Museum, Oxford.



Figure 2.16 Double unguent bottle. H 216 mm. Fourth or fifth century AD. Syria. Toledo Museum of Art, Ohio.

range of distribution. For example, the Syrian double unguent bottle (Figure 2.16) is later than fourth century, and is not found in the West. In due course the regional styles developed into the glass types of the Teutonic north on the one hand, and the Syrian, Iranian and Egyptian styles of the Islamic period on the other.

Post-Roman glass in north-west Europe

There were marked cultural changes after the fifth century when barbarian incursions replaced central imperial power. The changes were reflected in glass-making by a general technical decline. The metal was inferior in quality and colour to Roman glass, and the vessel shapes were generally simpler. However, they were decorated with glass applied with considerable manipulative skill (Harden, 1956b, 1969, 1971, 1978).

In the northern European countries glass-making tended to move away from the centres of population into the forests which supplied fuel for the furnaces. It is possible that natron continued to be transported to these countries even after the collapse of the Roman Empire in the West, by overland routes through the Brenner Pass in Switzerland, by sea around the Iberian Peninsula, or up the Rivers Vistula and Danube (Besborodov and Abdurazakov, 1964; Besborodov and Zadneprovsky, 1963). However, at some time before the tenth century, the ash produced in glass furnaces was substituted for the ashes of marine plants which had been the almost universal fluxing agent used in Roman glass-making. This change to potash derived from the ashes of burnt trees, especially beech, resulted both in a change of alkali and lime contents of the glass, which is known as *forest glass* (Ger. *Waldglas*; Fr. *verre de fougère*—fern glass). The relationships of the northern glasshouses to the distribution of beech pollen in AD 1000 is discussed by Newton (1985b). The northern forest glass-makers conditioned by their raw materials, produced mainly green and brown glass, and



Figure 2.17 A Saxon claw beaker. H 158 mm. Late fifth or early sixth century AD. Found at Castle Eden, Co. Durham in 1775. British Museum, London.

decorated it with furnace-wrought embellishments of simple rib-moulding, applied trails and blobs, mostly in the same colour glass as the body of the vessel itself. The vessels fall into several categories: simple palm cups without handles, bag beakers, cone cups up to 265 mm in height and tapering to a pointed base, a variety of squat pots and bottles, and claw beakers (Ger. *Rüsselbecher*) (Figure 2.17).

The known glass-making centres at this time were Cologne, Liège, Namur, Amiens and Beauvais. It seems likely that glass was exported to Britain from northern Gaul and the Rhineland during the first seven centuries AD, but there was certainly some local production, at least from the seventh century.

Glassmakers seem to have been working in the Kentish kingdom in the seventh century because bag beakers and squat jars are more prolific there than on the continent; moreover, a glass furnace was found in the cloisters of Glastonbury Abbey near Bristol, beneath the medieval levels. With the spread of Christianity, the practice of burying grave goods with the dead slowly declined in Britain, northern France and the Rhineland. However, the custom continued in Scandinavia until the beginning of the eighth century so that the major source of glass from this period is from Scandinavian excavations.

In the course of the later Middle Ages glass was improved to produce a substantial material of beautiful quality and a variety of green tones, used in a characteristic range of shapes of great originality and charm.

Little is known of glass-making in the Rhineland from the eighth to the fifteenth centuries. A few specimens have been found which provide enough information to show that glass was made during this period, but it appears to have been confined to small, crudely made vessels of strictly utilitarian purpose. Two important pieces are reliquaries containing parchments dated 1282 and 1519. The former was discovered in a church at Michelfeld near Hall, and is a small jar decorated with trailed threads reminiscent of the trailed-thread snake vases made in Cologne in the third century. The latter is a short parallel-sided beaker called an *igel* (Ger. hedgehog) the name being given because the applied decoration in the form of a series of spikes resembles the spikes of a hedgehog.

The general term for applied blobs of glass is *prunts* (Ger. *Nuppen*); and prunts are one of the most characteristic features of northern European glass from the late fourteenth century onwards (Figure 2.18). It is possible to draw a parallel between these prunts and the projections on late Roman glass vessels, and on Seine-Rhine claw beakers. Whereas in the earlier glasses the prunts were hollow blown and drawn out to form the distinctive long claws, the later prunts were restricted to solid lumps of glass which owed their appearance and decorative effect to the manner in which the surface was finished. They were drawn out in several styles. They were drawn out to produce thin spikes resembling thorns, drawn out and folded over to form loops from which small rings of glass were suspended, and drawn into curls and pressed back onto the surface of the vessel to resemble pigs' tails. They were also flattened and moulded to produce a beaded surface; these are commonly known as raspberry or strawberry prunts.

Gradually the squat *igel* became taller whilst retaining its parallel sides until glasses were made which were in excess of 300 mm high. This type of vessel became very popular and acquired different names according to their intended use and style of decoration. One version decorated with a row of

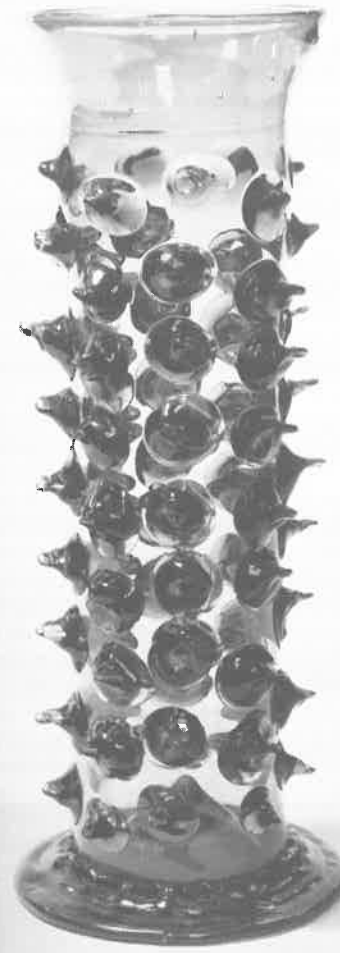


Figure 2.18 A *stangenglas*, a tall cylindrical vessel decorated externally with eight vertical rows each of nine prunts (and internally with eight rows of seven prunts). Dark blue-green glass. H 260 mm, D 81 mm. Early sixteenth century. Probably Rhineland. British Museum, London.

prunts which resembles broken-off leaf stalks was termed *krautstrunk* (Ger. cabbage stalk). Another version was a plain glass divided into zones by horizontal trailed rings, the *passglas* (Ger.) which each drinker in turn was expected to drain to the next division in one breath.

Origins of painted glass windows

The origins of decorated glass windows can only be speculated since no contemporary account of their use is known. Coloured window glass was known in



Figure 2.19 Excavations in 1932 at Lorsch Abbey in Germany unearthed fragments of painted glass which are thought to date from the ninth or tenth century. In spite of the dark gaps of missing glass, a head of Christ is suggested by this reconstruction of the ancient pieces, believed to be the earliest existing pictorial window glass. Darmstadt Museum, West Germany.

Saxon times (Cramp, 1968, 1970, 1975); and a sixth-century fragment of window glass from Ravenna in northern Italy bears an outline drawing; but the earliest painted glass known is the ninth-century head of Christ from Lorsch in Hesse which is now in the Darmstadt Museum, Germany (Figure 2.19). The earliest surviving picture windows are the Augsburg Prophet Windows which date from circa AD 1130, and the Le Mans Ascension window of AD 1145. These examples are so fully developed that there must have been many precursors which have either perished or were destroyed in favour of a later replacement or, more likely, considering the major losses which would seem to have occurred, were lost by the deliberate destruction of the older (Byzantine) windows by the proponents of the Gothic era.

Glass-making in the medieval period was clearly dominated by the great demand for window glass for the cathedrals and churches being erected at the beginning of the Gothic era. Barrelet (1953) states that, for the cathedral of Chartres alone, at least 2000 m² of glass was required over a period of 30 years; this would correspond to about 8 m³ of glass or about 20 tonnes. It is therefore not surprising that there could have been a fuel crisis at the coastal

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1500 BC are stripes and spots; later developments are eye beads and beads with zig-zags and chevrons. Egyptian beads were exported to many countries. These early beads were normally made of opaque glass, frequently blue with decoration in yellow and white. In the Roman era leech beads were sometimes used to cover the bow of fibulae. They were slightly curved, hollow cylinders with marvered combed decoration in a feather pattern. Some were made of Etruscan glass in the seventh century BC.

Since the manufacture of glass beads could only be carried out in furnaces hot enough to melt iron, their production in Britain is mainly associated with the Romano-British period; although on the Continent large annular beads and armlets were made in the La Tène I period (fifth century BC) (Ankner, 1965). Guido (1977) has published a comprehensive study of prehistoric and Romano-British beads found in Britain and Ireland. Many of the beads were imported but a map is included showing six local glass bead-making sites. There are also many distribution maps for different types of beads. In some cases the beads or bracelets were made by reshaping fragments of Roman glass articles, such as the bracelets from Traprain Law, and there is a strong suggestion that the highly coloured glass used for the applied decoration (spirals, eye spots etc.) was an article of trade imported from a glassworks which specialized in making coloured glass, perhaps in Gaul (Henderson, 1987).

Callmer (1977), discussing beads found in Scandinavia, described the same six manufacturing techniques mentioned above, plus that of producing beads by cold cutting blocks of glass. He has published a map showing probable areas of manufacture for beads of the period *circa* AD 800–1000, and discussed the part played by beads in developing trade routes (Callmer, 1977). Scandinavian bead-making is also discussed by Lundström (1976) who concludes that glass tesserae, glass sherds and glass rods were used as raw material for making glass beads, especially at Helgö. Some unperforated beads have been found at Helgö, and it is not clear whether these were defective beads, whether they were awaiting perforation, or whether they represented glass weights or a kind of currency. The discovery of crucibles, with attached glass, at Helgö and Paviken seems conclusive proof that bead-making was carried out locally (Lundström, 1976).

Asahina and Oda (1954) conclude that Japanese glass beads were made in one of two ways: by drawing a tube, cutting it into short lengths and then manipulating it into a bead; or by drawing a glass thread and winding it on a metal thread coated with clay so that the rod could be easily withdrawn. Glass beads in Malaysia are discussed by Lamb (1966). Dekówna (1967) has published a bibliography of selected publications on glass beads, together with

chemical analyses of fourteen beads. She discusses the typology of beads and the advantages and disadvantages of different analytical techniques from the point of view of research. In another paper Dekówna and Szymanski (1970) discuss petrographic techniques for discovering how glass beads were made.

In Venice in the eleventh century and subsequently, glass beads were made for trade. Later they became popular in Bohemia and elsewhere, being made in many forms and styles including translucent, iridescent, faceted and enamelled in various colours. At present the principal sources of beads are Venice, Japan and the Gablonz region of Czechoslovakia. Some are of good quality and serve as costume jewellery, but vast quantities serve merely as tourist souvenirs. Coloured beads may be either inferior varieties coloured only on the surface, or be made entirely of coloured glass.

Most of the methods used in making glass beads can be applied to the manufacture of producing bangles. If not cut from a solid piece of glass, however, the commonest means of producing bangles are either by bending a glass rod round and fusing the two ends together; or by first blowing a hollow glass cylinder and then cutting it into short lengths. In the latter instance it is not uncommon to find that the glass gathering has been cased with several layers of differently coloured glass. All methods of decorating glassware can be applied to bangles (Hodges, 1964; Haevernick, 1960).

Fourteen hundred years before the invention of glass-blowing, four very different techniques were already in use for the production of glass artefacts:

core-forming; *moulding*; *cutting or abrading* (cold glass); and *mosaic*.

Core-formed vessels

The majority of pre-Roman glass vessels were made by the core-forming method. A core modelled on the end of a wooden rod to form the inside of the vessel would be dipped into the molten glass. When sufficient glass had been gathered the outer surface was rolled smooth (*marvered*) on a flat stone surface. Alternatively the glass was first drawn into rods (*canes*) which were then softened by reheating and wound round a core. The glass and the core were then repeatedly reheated, rotated and marvered to produce a smooth outer surface. A decoration of coloured glass blobs and trails could then be added and trailed (*combed*) into zig-zag patterns and embedded into the surface by reheating and marvering. Additional parts such as rudimentary handles, stems and footings might be added; then on cooling the rod was removed and as much as possible of the core picked out, following which a rim could be trailed on and shaped.

The carrot and lentil shapes of the earlier vases and bottles were natural marver shapes and these vessels were usually about 80–120 mm in height, although a few larger examples exist. Core-formed vessels were mainly produced in Egypt but examples have been excavated in Mesopotamia, Cyprus, Syria, Crete, Rhodes and Greece.



Figure 3.3 Core-formed vessels of different periods, sixth to first centuries BC. These vessels illustrate the variety of

shapes made on cores, in the Hellenic and Hellenistic periods. H 77–184 mm. British Museum, London.

manufacture, or shortly afterwards during their functional life (Lillie, 1936).

The development of glass bead-making

The earliest vitreous material had been used in Egypt before *circa* 4000 BC, as a glaze to cover beads of stone and clay in imitation of coloured semi-precious stones. Later, *circa* 2500 BC, when furnaces were able to be maintained at temperatures high enough to soften glass, the same material was used in Egypt to make beads which were the first objects to be made entirely of glass. Glass beads are known from Mycenae from the sixteenth to the thirteenth centuries BC. Glass paste beads made at Mycenae *circa* 1300 BC are in the form of small thin tablets of which the ends are ribbed and perforated for threading. They were circular, rectangular or triangular, and usually of blue or pale yellow glass. The beads are decorated with relief Mycenaean motifs, such as rosettes, ivy and spirals. They were formerly believed to have been used for necklaces and as decoration on garments, but a recent view is that the beads were also used to adorn diadems and the skulls of skeletons (Yalouris, 1968).

Glass beads can be made by at least six methods: winding threads of glass round a rod; drawing from a gob of glass which has been worked into a hollow; folding glass around a core, the join being visible on one side; pressing glass into a mould; perforating soft glass with a rod; and blowing (though cylindrical blown glass beads are rather exceptional). Bead-making by perforating glass with a rod is a technique still used in Africa as illustrated by Haevernick (1961). The same methods of decoration were applied to glass beads as to glass vessels, that is thread inlay, mosaic inlay, *millefiore* etc. An agate effect was produced by casing glass tubing with layers of differently coloured glass and then chamfering down the ends of cut lengths to expose the various layers. Examples of this type are the aggrry (aggri) beads excavated in Africa (Hodges, 1964; Haevernick, 1961; Lamb, 1970).

The early decorative patterns on beads from *circa*