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The Archaeology of Medieval and Post-Medieval Kitchen and Cuisine: Food - Utensils - Space

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Rough Beauty. The Case of Ice Glass. Finds from the Tykocin Castle, Poland, and Beyond

Abstract

Ice glass was invented by glassmakers in Renaissance Venice. Its distinctive surface texture made it an original and very visually appealing item, desirable as fine tableware in the modern era. It was manufactured not only in its place of origin but also in other glass-making centres north of the Alps, especially in the Low Countries. Examples of this glass are known primarily from museum collections and are relatively rarely recorded among archaeological finds. The article aims to discuss the unique finds of ice glass, dated to the 17th century, discovered at the Tykocin Castle complex in north-eastern Poland. An attempt is made to establish their form, function, and attribution through comparative analyses based on museum exhibits and archaeological artefacts from Poland and beyond. The finds from Tykocin can be seen as part of the broader phenomenon that was the popularity of Venetian glass and its imitation, i.e., *façon de Venise*, in modern Europe.

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KEYWORDS
- ice glass
- vetro ghiaccio
- façon de Venise
- Venetian glass
- post-medieval glass
- the Tykocin Castle

Introduction

Ice glass is a high-quality glassware distinguished by its characteristic surface decoration. Its origins are closely tied to the development of Venetian glass-making and can be traced to the peak of its evolution, likely in the first half of the 16th century. Ice glass was initially produced on the Italian island of Murano, and over time (during the 2nd half of the 16th and in the 17th century), it began to be manufactured in glass workshops operating outside the Italian Peninsula, specialising in imitations of Italian prototypes (Fig. 1).

Today, ice glass is relatively rarely recorded among archaeological finds and, if discovered on site, is retrieved in varying states of preservation. However, in museum collections, there are complete glass objects of many different types and designs, which are exhibited as valuable works of historical craftsmanship and decorative art.

This study focuses on fragments of ice glass discovered during excavations carried out at the Tykocin Castle site in Podlasie (Podlachia), north-eastern Poland. The article's main aim is to determine the original form, function, and attribution of these glass items through comparative research. To this end, information on similarly decorated objects from various museum collections and archaeological assemblages in Poland and abroad has been gathered and presented below. Studies of the form are supported by the results of archaeometric analyses. The paper serves as an introduction to the subjects relating to the production and consumption of ice glass vessels in the early modern era.

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Fig. 1. Ice glass beaker with dark ale in the painting from 1658 by Pieter van Anraadt, *Still Life with Earthenware Jug and Clay Pipes*, from the collection of The Mauritshuis, The Hague (Netherlands). Source: Mauritshuis 2024. Public domain.

The research on this subject was primarily based on a review of Polish and international publications, online databases of European and American museums, as well as antiques auction catalogues. The collections of the following four institutions were particularly useful here: The British Museum in London (The BM),[1] The Corning Museum of Glass in Corning (CMoG),[2] The Metropolitan Museum of Art in New York (The MET),[3] and the Rijksmuseum in Amsterdam (RM).[4] These collections included a wide variety of ice glassware, photographic documentation, and descriptions of the objects, all of which facilitated their use for comparative studies. The offerings of the British auction house Christie's also provided information about notable examples from the 16th and 17th centuries.[5] The gathered artefacts offer insights into the range, appearance, and scale of ice glass production during this period. The study of Venetian and Venetian-style glass is predominantly approached from historical and art-historical perspectives. For this reason, publications prepared from this point of view, particularly museum catalogues that present glass collections and explore various aspects of the glass-making craft's history, were an invaluable source of information.[6] Finally, archaeological publications provided comparative material for the artefacts discovered in Tykocin, which is discussed in this paper and includes information on this type of finds.[7]

The review of the existing literature indicates that ice glass has not been the subject of dedicated studies. One of the most recent articles in which this type of glass receives more attention concerns various Venetian-style glassware from Elbląg. Its author focuses on technological issues, but within a broad historical context.[8] Archaeometric studies of glasses produced in the early modern period on the island of Murano and its imitations, including ice glass, form a separate and complex issue, with a vast body of literature. However, this requires a dedicated approach, which is why it is not further developed here. This scope of the study was limited in order to utilise the results of specialised research to identify the main types of glass from Tykocin. For this purpose, chemical composition analyses using the SEM-EDS method were also conducted on three fragments of ice glass discovered within the castle complex, and these results are included in this article.

Venetian glass and *façon de Venise*. Brief historical background

The terms 'Venetian glass' and 'à la façon de Venise' are key to the history of European glass-making in the early modern period. Not only do they refer literally to the glass produced in Venice and beyond – made 'in the Venetian style' – but they also carry a broader meaning, encompassing a complex set of transformative phenomena in glass production during the 16th and 17th centuries, integrated with the socio-economic changes of the time, including shifts in social customs and artistic trends. In glass-making, this led to an evolution in the production of vessels, an increase in the number and variety of forms, and the introduction of previously unseen decorative techniques. These new methods radically changed the appearance of glassware. Thus, from simple, functional objects, they evolved into beautiful creations. Furthermore, glass-making was transformed from a humble, utilitarian craft into a sophisticated courtly art. The Murano glass industry and its luxury products achieved supremacy in this regard.[9]

Various factors contributed to the development of Venetian glass-making in the post-medieval period, including the established tradition of the

[1] https://www.britishmuseum.org/collection (available on-line 02.10.2024).

[2] https://glasscollection.cmog.org/collections (available on-line 04.10.2024).

[3] https://www.metmuseum.org/art/collection (available on-line 06.10.2024).

[4] https://www.rijksmuseum.nl/nl/collectie (available on-line 10.10.2024).

[5] See https://www.christies.com/en (available on-line 05.10.2024).

[6] E.g., Tait 1979; Theuerkauff-Liederwald 1994; Hess and Husband 1997; Baumgartner 2003; Page 2004; Brüderle 2013; Strasser 2016.

[7] E.g., Gołębiewski 1993; Gołębiewski 1997; Willmott 2002; Ring 2003; Gołębiewski 2004; Nowosielska 2004; Gołębiewski 2005; Hulst 2013; Finn 2014; Tausendfreund 2014a; Tausendfreund 2014b; Sedláčková and Rohanová 2016; Röber 2022; Traudt 2022; Rohanová et al. 2024.

[8] Kunicki-Goldfinger 2021.

[9] See Tait 1979, 9.

industry, the influx of knowledge, skill, and materials from Syria, the growing importance of the city in trade, commerce, and culture, the broader cultural context of the Italian Renaissance, and the quality of available raw materials. As a result, from the 15th to the end of the 17th century, Venice became the world leader in glass-making. Its fame spread through the export of fine glassware and glass beads.[10] This was also reflected in the extraordinary quality of glass – its homogeneity, transparency, decolouration, and the vibrant colours in its palette – as well as its distinctive style and wide range of products.[11]

Venetian artisans experimented extensively with many aspects of the glass-making process. Obtaining glass of such high quality resulted from continuous improvements in the selection of raw materials and the refining of the melting process. The essential ingredients included plant ash (used as a flux) imported from the Levant, and since the 16th century, also from Spain (*barilla*),[12] as well as quartz pebbles from the Ticino River.[13] Due to the presence of sodium, Venetian glass was particularly suited to complex hand-moulding techniques. These factors contributed to numerous technological innovations, such as chalcedony glass, *lattimo* (opaque-white glass), and a new type of very pure, transparent glass known as *cristallo* (introduced in the mid-15th century).[14] The most extraordinary and complex ornaments were achieved with the *filigrano* (filigree) technique,[15] involving *vetro a fili*,[16] *vetro a reticello*,[17] and *vetro a retorti*.[18] These styles dominated European tastes in glass tableware over the next two centuries.[19] Elegant and intricate forms such as bottles, cups, dishes, phials, and saucers were produced,[20] with beakers and goblets displaying the greatest diversity in design.

Their production catered to the consumerist desires of Renaissance societies, shaped by the new customs emerging in the 16th century. Gradually, there was a transformation in behaviour, including the refinement of table manners, particularly in terms of codified service and consumption of drinks. Early modern feasts manifested this new complexity through more elaborate food and its presentation, an array of vessels (both for display and for practical use), ornate settings, and diverse entertainments. This evolution was accompanied and partially driven by a craving for novelty and social ostentation.[21] With its sophisticated forms, Venetian glassware aligned perfectly with these trends, becoming 'objects of pleasure and enjoyment […]'.[22]

The growing demand for Venetian glass, coupled with the high costs of export to countries distant from Italy, resulted in efforts to produce similar glassware north of the Alps. The goal was to meet local market demand more quickly, on a larger scale, and according to individual orders, as well as to provide access to more affordable products.[23] In order to maintain its monopoly on glass-making, Venice sought to keep its knowledge and production methods secret.[24] However, from the 16th century onward, thanks to artisans migrating from Murano and Altare near Genoa (Venice's traditional rival), Italian expertise spread throughout Europe, reaching countries in the north and west. Many glass workshops in Austria, England, France, Germany, Sweden, and the Netherlands (e.g., in Antwerp, Hall in Tirol, Innsbruck, Liège, London, Nevers, Stockholm, Vienna) began producing *façon de Venise* glassware, particularly in the second half of the 16th and the first half of the 17th century. As a result, Venice gradually lost its supremacy in the glass industry.[25]

Façon de Venise is a French term traditionally used to describe the high-quality soda or mixed-alkali glass made in the 'Venetian style' or 'Venetian manner,' i.e., imitating the original Murano products. It was popular in the 16th and 17th centuries.[26] Glassmakers in different parts of Europe tried to imitate

[10] Rasmussen 2012, 43.

[11] E.g., Verità 2009, 1.

[12] A term from Spanish meaning plant, *Salsola soda*, which grows extensively on seashores in the western Mediterranean and the Canary Islands; or an impure alkali made by burning plants of this and related species, formerly used in the manufacture of soap and glass, Whitehouse 2006, 13.

[13] E.g., Verità 2009, 1; Rasmussen 2012, 44-48; Verità 2014, 54-59; Traudt 2022, 35.

[14] E.g., Traudt 2022, 35. The term was compared to natural, colourless rock crystal, although most Venetian *cristallo* had a grey or brownish hue, Whitehouse 2006, 26. *Cristallo* glassware were luxurious items, costing, in the 15th century, almost a hundred times more than ordinary stemware, e.g., Maitte 2015, 219.

[15] Tait 1979, 25, 49-50.

[16] The Italian term meaning 'glass with threads.' A type of blown glass made with canes that form a pattern of parallel lines, Whitehouse 2006, 87.

[17] The Italian term meaning 'glass with a small network.' A type of blown glass made with canes organised in a crisscross pattern to form a fine net, which may contain tiny air traps, Whitehouse 2006, 87.

[18] The Italian term meaning 'glass with twists.' A type of blown glass made with canes that have been twisted to form spiral patterns, Whitehouse 2006, 87.

[19] See Verità 2014, 57.

[20] Tait 1979, 49.

[21] E.g., Hills 1998, 163-168; Gaba-Van Dongen 2004; Rihouet 2013, 4-13; Finn 2014, 225-243; Maitte 2015, 209-211, 216-218; Burkart 2021, 58-59, 67-70.

[22] This is how the aldermen of Macon in 1583 described them, Maitte 2015, 210.

[23] E.g., Polak 1981, 103.

[24] E.g., Tait 1979; Rasmussen 2012, 43.

[25] Tait 1979, 50, 94-96; Polak 1981, 103-118; Davison 2006, 34.

[26] E.g., Willmott 2002, 132; Whitehouse 2006, 34.

genuine Venetian products by following authentic Venetian recipes.[27] This production developed best and lasted the longest in the Low Countries and in France, which — due to their geographical location, level of urbanisation, and the wealth of their societies — were able to ensure supplies of the necessary raw materials and had a suitable market for their products.[28] As the raw materials were imported from traditional sources, the result was that the composition of the *façon de Venise* glass produced abroad by Murano glassmakers was quite similar to the genuine Venetian glass.[29] The participation of Italian artisans in Western European glass-making also allowed for a further evolution of this craft. Besides their influence on the production and appearance of vessels, regional styles were also present in the glass manufacturing process. Over time, each country developed a set of individual features that distinguished its glass products. Imitations of Venetian glass were varied and complex, but as with the Italian specimens, the assortment of glassware consisted mainly of beakers and goblets.[30]

The displacement of *façon de Venise* vessels from the European markets in the 17th century was the result of many factors. The first reason was, as mentioned above, the spread of Murano technology, forms, and decoration techniques all over Europe, and the development in *façon de Venise* production. The secrets of Venetian glass-making were made public, at first, by a printed manual entitled *L'Arte Vetraria* published by Antonio Neri in 1612. The text became popular and was translated into numerous languages. Other books followed over time. Another cause of the decline was the discovery in Bohemia and in England of new glass types. In 1676, Johann Kunckel invented a potash-lime-silica crystal glass, and in the second half of the 17th century, George Ravenscroft began producing lead-silica glass. This clear and bright glass was cheaper than the Venetian *cristallo* and became more available on the market. It led to the fashion for German and English glassware and its specific ornamentation. The changes associated with the new Baroque style were also evident in glass-making, including the art of cutting and engraving. The soda-lime glass of the Venetian formula was unsuitable for these decorations.[31]

Ice glass and its properties

Ice glass — Italian *vetro ghiaccio* (*vetro a ghiaccio*) — was invented by Venetian glassmakers probably in the first half of the 16th century.[32] It is characterised by a decorative effect that makes the outer surface of the glass resemble cracked ice. This effect could be achieved in two ways. The first method involved plunging a parison of hot glass into cold water and quickly withdrawing it, with the action being repeated 15 to 20 times. The thermal shock created fissures in the surface, which gave the glass a frosted appearance once the parison was reheated to continue the forming process. The alternative method consisted in picking up chips of colourless glass on a gather (a gob of molten glass), rolling them across a flat surface, and fusing them to the bubble as it was reheated. It is impossible to distinguish which technique was used based on the final product. The resulting glass was translucent, but not transparent.[33] Thus, a physical reaction of the crafting process was exploited to obtain a distinctive decorative pattern, showcasing the ingenuity and imagination of Murano glassmakers. Distinguished by an uneven, seemingly imperfect texture, ice glass was the opposite of the smooth and clear *cristallo* that was the hallmark of Venetian workshops at the time. In the end, vessels with roughened surfaces also found their connoisseurs[34] and spread from Venice to Northern Europe, where they remained in vogue until the 17th century.[35] Their original appearance continued to be recreated in 19th- and 20th-century glass art.[36]

Based on the review of museum collections and archaeological finds,[37] it is proposed that various forms of modern ice glass vessels were produced[38] (Figs. 2–4): beakers, bottles, bowls (some resembling vases), buckets (also referred to as baskets or aspersoria), decanters, goblets (some with lids), jugs/pitchers, tankards, and miscellaneous forms such as *càntir.*[39] The dominating form is beakers, while other forms are comparatively rare.

[27] Kunicki-Goldfinger 2021, 18.

[28] E.g., Liefkes 2004; Gołębiewski 2005, 164.

[29] E.g., Tait 1979, 27; Verità and Zecchin 2006, 610.

[30] Finn 2014, 58-59; Traudt 2022, 36-37.

[31] E.g., Tait 1979, 95-96; Verità 2014, 62.

[32] After Courtney 2004, 333; *vetro a ghiaccio* is mentioned, e.g., in the Bortolo d'Alvise's inventory from 1569, Barovier Mentasti and Tonini 2015, 21.

[33] E.g., Hess and Husband 1997, 178; Whitehouse 2006, 45; Rohanová et al. 2024, 195; films presenting the production of ice glass: Gudenrath 2016; Barovier Mentasti 2024.

[34] Tait 1979, 94; Scuro 2021, 118, 121, e.g., King Philip II of Spain in 1564 had 65 items in his palace El Pardo.

[35] Davison 2006, 34.

[36] This is evidenced by the museum exhibits, for example, in the CMoG collection.

[37] Cf. footnotes 1-7.

[38] Different vessels are presented *i.e.* on drawings of Giovanni Maggi in *Bichierografia* from 1604, Theuerkauff-Liederwald 1994, 29, 30, footnote 9.

[39] *Càntirs* – drinking vessels shaped like a closed jug, with a ring handle at the center and two spouts, produced in Spain, Doménech 2004, 103; see *càntir* from the 18th century from the collection of the Museu del Cau Ferrat, Sitges, cf. Doménech 2004, 102, fig. 20.

Fig. 2. Ice glass. Examples of vessels from the collection of The MAK – Museum of Applied Arts, Vienna (Austria), at the permanent exhibition: a – beaker with applied mascarons from the mid-16th century, Antwerp or Venice. Source: Strasser 2016, no. 80; b – covered goblet, Venice, ca. 1568 or Innsbruck (Hofglashütte), after 1570. Source: Strasser 2016, no. 89; c – vase from the 2nd half of the 16th century, Venice. Source: Strasser 2016, no. 86. Photo: W. Bis, graphic design: M. Bis and W. Bis.

Beakers typically have a slightly flaring shape with a slightly turned outwards rim; less frequently, the vessel walls are straight (cylindrical) or occasionally take the form of a barrel; the base has a foot-ring. The sizes of complete vessels vary, with specimens that can be divided into two groups: larger examples, typically 14 to 22 cm in height with a rim diameter of approximately 10-12 cm (Fig. 2:a; 3:a; 4:f), and smaller ones (serving as cups), which are approximately 4-10 cm high with a rim diameter of 7-8 cm (Fig. 4:b-d). The largest, unique specimen mentioned in the literature comes from Alkmaar in the Netherlands. It is 30.5 cm high with a rim diameter of 20.5 cm[40] and has a capacity of over seven litres.[41]

Based on the studied collections and literature, the most elaborate forms are represented by buckets and goblets. Buckets are rarely preserved as intact specimens. They have a round, bulbous bowl with conical sides rising to a profiled rim (including octagonal in shape). They are also fitted with loops into which a glass handle is hooked, allowing the vessel to be carried. The items are approximately 9-12 cm high and have a rim diameter of around 15-18 cm (Fig. 4:g). Goblets are ca. 18-22 cm high. Their individual parts vary in shape, typically featuring wide feet and spindle-shaped cups or bulbous bodies, which are visually separated from the rim. Some examples are equipped with ice glass-patterned lids (height of goblets with lids – ca. 29 cm). Basic profiles of the lids are collared and domed, with a central knob handle (Fig. 2:b-c; 4:a).

The described standard glassware – i.e., the beaker of a flaring shape, the bulbous goblet, and the domed cover – belonged to the repertoire of typical Venetian forms in the 16th century. These forms were also produced in other versions, such as *vetro a fili*. Eventually, they were replicated as *façon de Venise* glass.[42]

The ice-like surface covered either the entire body or part of it, most commonly the belly in multi-part objects. Most glass vessels had additional decorative elements created using various techniques, including moulded feet, milled foot-rings, and applied coloured threads (forming bands; with blue being particularly common) (Fig. 2:b; 3:c; 4:a, b, e, g), prunts (mascarons, rosettes) (Fig. 2:a) or beads, finely profiled bowls (Fig 3:b), moulded baluster stems (adorned with gadroons, lion masks, trailed wings), and diversely formed handles (e.g., twisted) (Fig. 4:e, g). Gilding was also used to highlight certain details (prunts, rims) (Fig. 2:a, b). On some specimens, an optical blown pattern or vertically ribbed decoration is evident, imprinted before the ice-texture effect was applied (Fig. 2: b–c; 4:a, c, f).

The glass, depending on the chemical components, was usually colourless or of a slightly greyish colour (original Venetian glass), with brownish, yellowish or greenish hues (*façon de Venise*), and only occasionally intensely tinted (e.g., purple-red[43]).

Most of the vessels were used as tableware for serving or consuming drinks, mostly beer and wine. Given their ornamental nature, ice glass undoubtedly also served as splendid decorative items

[40] Finn 2014, 247, fig. 11.4.(3).

[41] Hulst 2013, 33, fig. 19.

[42] Cf. e.g., Tait 1979; Hess and Husband 1997; Baumgartner 2003; Page 2004.

[43] Beaker in the CMoG collection, dated: 1670-1700, provenance: possible the Low Countries; Accession no. 79.3.441, https://glasscollection.cmog.org/objects/62452/beaker (available on-line 15.10.2024).

Fig. 3. Ice glass. Examples of vessels from the collection of The MET – Metropolitan Museum of Art, New York (United States): a – beaker from the late 16th–early 17th century, Venice or *façon de Venise* (probably south Lowlands) (MET 2024a); b – bowl from the 17th century, Spanish (probably Catalonia) (MET 2024b); c – pitcher from the early 17th century, Venice or *façon de Venise* (MET 2024c). Public domain; graphic design: M. Bis and W. Bis.

and a display of wealth. Buckets are an exception; they could have served as cooling bowls but also as portable fonts for holy water, intended for private or church religious practices.[44] Such a vessel is known as an aspersorium.[45]

Based on the items found in museum collections, formal and stylistic features can be identified that are either common for all ice glass vessels or that differentiate the objects in terms of provenance. Therefore, the stylistic approach can serve as the primary analytical method to distinguish between imported and locally produced items. A key common element is the frosted surface, though the texture is not universally homogeneous. In its most distinct form – an irregular network of depressions and raised areas – it is found on Renaissance vessels attributed to Venice as well as on high-quality Western European imitations (see Figs. 1; 2:a; 3; 4:e, g). This result was achieved through a carefully executed production process, involving repeated cooling and reheating of a parison, which enhanced the desired crackling effect. A more delicate, less 'substantial' texture characterises some Venetian-style pieces dated to the 17th century. This is especially true for specimens in which the ice-like surface complements another decorative feature, such as an impressive vessel shape (e.g., ribbed moulded body) (see Fig. 2:b-c; 4:a, c, f).

Designs of this kind are suggestive examples of the reduced role of the analysed ornament: from the perfect original, initially imitated with great care, to a modified, secondary decoration executed in a simplified manner. The combination of these two decorative techniques – if the observation can be inferred from the published material – was not used in Italian glassworks. This assumption is worth considering as a potential attributional and chronological clue. Of course, it requires verification through detailed studies of vessels from European glass-making workshops, alongside written sources regarding the appearance of their products and employed decorative methods.

The literature also identifies other features distinctive from glassware made in the Venetian manner, which also applies to specimens with an ice glass surface and may help determine their attribution. These include typological factors such as the moulded foot-ring (Figs. 2:a and 3:a) and the shape of the pushed-in base of beakers. The milled foot-ring and round, low pontil mark are thought to be specific to vessels produced in a glasshouse called De Twee Rozen (Two Roses), operating in Amsterdam between 1621 and 1679.[46] Researchers suggest that such foot-rings are also found on glass vessels manufactured in other centres in the region: Antwerp, the Northern Netherlands, and possibly Liège. These vessels are of sodium glass (Si-Na-Ca).[47] In contrast, beakers made of potassium-calcium glass (Si-K-Ca) have a foot-ring milled only on the side, with the foot being plain or entirely absent. In most cases, the pontil mark on the bottom of the base is more pointed.[48]

Archaeological finds of ice glass in Poland and beyond

To date, only two ice glass finds from the territory of present-day Poland have been mentioned in archaeological publications[49] (Fig. 5). The first is a beaker discovered during excavations in the Old Town of Elbląg (Fig. 5:a). Located in northern Poland, Elbląg was an important craft and trade centre

[44] Hess and Husband 1997, 110-112; Barovier Mentasti and Tonini 2015, 21-23.

[45] See Gudenrath 2016.

[46] Hulst and Kunicki-Goldfinger 2017, 550-551.

[47] Hulst and Kunicki-Goldfinger 2017, 550.

[48] Hulst and Kunicki-Goldfinger 2017, 550-551.

[49] The lack of other ice glass finds has also been confirmed by researchers working on glass artefacts from archaeological excavations in cities where extensive fieldwork is currently being carried out: in Gdańsk, Stargard, and Wrocław.

Fig. 4. Ice glass. Examples of vessels from the collections: of the Rijksmuseum, Amsterdam (Netherlands) (a-d), of the National Museum in Kraków (e), the National Museum in Warsaw (Poland) (f), and of the J. Paul Getty Museum in Los Angeles (United States) (g): a – goblet from ca. 1550 – ca. 1600, Low Countries (RM 2024a); b-d – beakers from ca. 1550–ca. 1650, Low Countries (RM 2024b; RM 2024c; RM 2024d); e – bowl/vase from the 1st half of the 16th century, Venice (MNK 2024); f – beaker with lid from the 1st half of the 17th century Netherlands (MNW 2024); g – bucket from 1550–1600, Venice or Netherlands. Source: Getty 2024. Public domain; graphic design: M. Bis and W. Bis.

since the Middle Ages and a former Hanseatic town, where, from 1579, the headquarters of the East India Company was situated. The artefact was found during exploration in the patrician quarter, conducted between 1984 and 1995. The base with a mill-trailed foot and the lower part of the cylindrical body have survived (up to a height of approx. 6 cm, with a wall thickness of 3.6 mm). The bottom of the base (8 cm in diameter) has a round, low kick-up and a blow-pipe pontil mark. The centre of the body was originally decorated with three small oval lion-mask prunts; one of these remains. The texture resembling ice is distinct and 'substantial'. The beaker is made of clear, colourless glass with a light grey tint, of the sodic glass type (containing plant ash). The chemical specification of the glass was determined through archaeometric analysis.[50] The external surface has undergone slight iridescence, resulting in some brownish discolourations. The item is dated to the 16th-17th century.[51] Its shape corresponds to that of many other large *façon de Venise* beakers. Based on the decorative applications with mascarons, the milled foot-ring, and the type of glass used, it is attributed to a 17th-century glasshouse in Amsterdam.[52]

The second item (Fig. 5:b) was found in Wrocław, a major Silesian city that, in the early modern period, lay outside the Polish borders and was under Habsburg rule. It is now located in the southwestern part of the country. The artefact was discovered during archaeological research in the quarter at the junction of 5-13 Św. Antoniego St. and Kazimierza Wielkiego St. (formerly 9-15 Złote Koło St.). Based on the glass items found there, including some impressive imported specimens, it has been suggested that at least some of the residents of the studied properties were wealthy.[53] The ice glass find is a small jug, largely preserved (up to a height of 11.4 cm), with a bulbous body, cylindrical neck (diameter 5.9 cm, without a preserved lip), and footless base (diameter 2.8 cm). The frozen surface texture is well-executed and very clear. The glass has a light greenish tint, but the exterior has turned brown due to iridescence caused by depositional conditions. The item is presumed to date from the 16th-17th century. It has not been subjected to archaeometric analysis;[54] the tint of the glass suggests a potassium (Si-K-Ca) type. No close analogies for this form of jug have been found.[55]

Based on the reviewed literature, it can be pointed out that, outside Poland, ice glass has been found in small numbers during archaeological excavations across various regions of Europe: from

[50] Kunicki-Goldfinger et al. 2008, 309, tab. 1; Kunicki-Goldfinger 2021, 23, tab. 1.

[51] Inventory no. EM/XV/4887, current no. EM/XXXI/3661, Gołębiewski 1993, 122-124, fig. 7:5; Gołębiewski 2005, 167-168, fig. 1:f; Kunicki-Goldfinger 2021, 14, fig. 1:a, b.

[52] See Kunicki-Goldfinger 2021, 22-29.

[53] Nowosielska 2004, 86.

[54] Find from refuse pit no. 120b, Nowosielska 2004, 58, tab. 1; 78, 83, fig. 13:1; Rohanová et al. 2024, 283-284, fig. 144a–b.

[55] One of the few ice glass jugs/tankards is held in the CMoG. It is, however, shaped differently, having a base with a foot ring and pear-shape body. Only the neck profile is similar, finished with a straight rim (https://glasscollection.cmog.org/objects/26464/tankard; available on-line 28.10.2024).

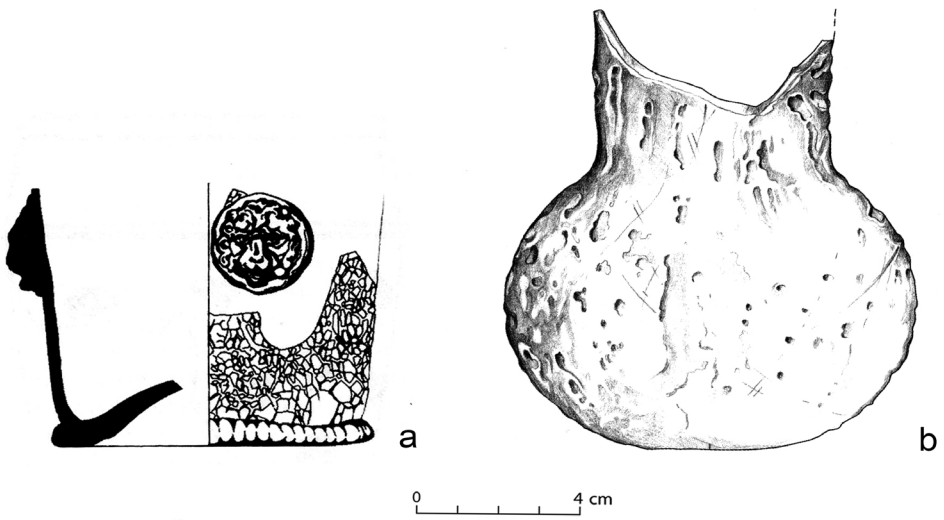


Fig. 5. Ice glass from present-day Poland: a – beaker from Elbląg from the 17th century. Drawing: B. Kiliński. Source: Gołębiewski 1997, 40, Fig. 2:1; b – jug from Wrocław from the 16th-17th century. Drawing: T. Demidziuk; Source: Nowosielska 2004, 83, Fig. 13:1. Graphic design: M. Bis and W. Bis.

the Croatian coast[56] and Portugal[57] in the south, England[58] in the west, through the present-day Netherlands,[59] Germany,[60] and Czechia[61] in the centre, and up to Estonia,[62] Finland[63] and Norway[64] in the north. Most of the mentioned artefacts are in poor condition, with only fragments typically preserved, which exhibit varying degrees of surface iridescence. In exceptional cases, the iridescence was so advanced that it altered the original glass colour and contributed to the degradation of its structure.[65] At individual sites, single sherds or, at most, a few to a dozen pieces are typically found. Few items have survived intact[66] or in a state that allows for identification of their type and form.[67] The artefacts are predominantly identified as beakers, rarely as other types of objects: goblets,[68] goblets or lids,[69] baskets//buckets (?),[70] bowls/vases,[71] jugs or pitchers,[72] and lids.[73] In some cases, the function remained undetermined.[74] Based on better-preserved examples, it can be observed that beakers have a slightly flaring body and a milled foot-ring; lids represent a domed type, while goblets feature spindle-shaped cups.

The items are dated from approx. the mid-16th to the early 18th century, based – according to the given information – on stratigraphy, analogies, and general knowledge about the chronology of Murano glasshouses and the production of Venetian-style glass in other European countries. Among the described objects, the oldest are likely the specimens from Acton Court, England (dated from context to the late 1540s)[75], while the newest were found

[56] The find from Gnalić wreck, Lazar and Willmott 2006, 66, no. S26f; 67, fig. 85:f; 133, plate 25:6.

[57] The vessel from Tarouca/Lamago, Coutinho 2016, 306, table VII.1, SJT0112; 313; Medici et al. 2017, 415, fig. 3, SJT0112.

[58] The beaker from London, Willmott 2002, 41, no. 1.11, fig, 15; Willmott 2004, 276, and specimens from Acton Court, near Bristol, Courtney 2004, 333; 334, tab. 43; 342, fig. 9.17:57.

[59] E.g., items found in Alkmaar, Hulst 2013, 37, fig. 25, Amsterdam, Hulst et al. 2012, 353; Hulst 2013, 29, fig. 11, Beverwijk, Hulst and Weber 2012, 435, fig. 9, Middelburg, Caluwé 2006, 295; Hulst 2013, 34, fig. 20a, and in Rotterdam (no. 11516-785.A-C; https://museumrotterdam.nl/collectie/item/11516-785.A-C; available on-line 20.10.2024).

[60] The beaker from Lüneburg, Ring 2003, 92, no. 2.041; beakers from Bocholt, Höxter, Münster, and Reine, Tausendfreund 2014a, 101-103; Tausendfreund 2014b, 19-20, no. 165-166; 159, no. 1586; 253, nos. 2606-2610; goblet or lid from Gelsenkirchen, Tausendfreund 2014b, 76, no. 737; beaker and lid from Ulm, Röber 2022, 243, 255, plate 10: 240, 241.

[61] Vessels from Brno: a goblet, Sedláčková and Rohanová 2016, 164, no. BoMe2_17-284, and jug (?), Rohanová et al. 2024, 31; 195, no. BoPan748-05a, b; a beaker from Olomouc, and an item from Košumberk Castle, Rohanová et al. 2024, 195.

[62] Beakers from Tallinn, Reppo 2023, no. AI 6332: I/539b; 1263b; Reppo 2024, 122, no. AI 6332: 1263.

[63] Two or three vessels from Siuntio, Niukkanen 2002, 491-492.

[64] The beaker from Bergen, no dating, Haggrén 2000, 40, fig. unnumbered.

[65] The find from Wrocław, Rohanová at al. 2024, 283-284, fig. 144a, b.

[66] E.g., item from London, Willmott 2002, 41, no. 1.11.

[67] E.g., finds from Bergen, Haggrén 2000, 40, fig. unnumbered, Beverwijk, cf. Hulst and Weber 2012, 435, fig. 9, Höxter-Brenkhausen, Tausendfreund 2014b, colour plate 18, no. 1586, Lüneburg, Ring 2003, 92, no. 2.041, and Ulm, Röber 2022, 255; plate 10: 240.

[68] E.g., Sedláčková and Rohanová 2016, 164, no BoMe2_17-284.

[69] Item from Gelsenkirchen, Tausendfreund 2014b, 76, no 737; Tausendfreund 2014a, 168.

[70] From Gnalić wreck, Lazar and Willmott 2006, 66-67, fig. 85:f, no. S26f.

[71] Artefact from Alkmaar, Hulst 2013, 37, fig. 25.

[72] E.g., item from Brno, Rohanová et al. 2024, 31; 195, no. BoPan748-05a, b and Wrocław, e.g., Rohanová et al. 2024, 284, fig. 144a, b.

[73] Find from Ulm, Röber 2022, 255, plate 10: 241.

[74] E.g., items from Acton Court, Courtney 2004, 333, 334, tab. 43; Middelburg, Caluwé 2006, 295; Siuntio, Niukkanen 2002, 491-492, and Tarouca/Lamago, Coutinho 2016, 306, Table VII.1, SJT0112; 313; Medici et al. 2017, 415, fig. 3, SJT0112.

[75] Courtney 2004, 333, 334, tab. 43.

in Gelsenkirchen, Germany (dated to the late 17th or early 18th century).[76] One of the more precisely dated objects is a basket/bucket recovered from a shipwreck off the Dalmatian coast in the Adriatic, which sank after 1582 (likely in the 1580s),[77] providing a *terminus ante quem* for its production. Other artefacts are mostly dated to the first half of the 17th century.

Most of the *vetro ghaccio* recovered archaeologically is regarded as *façon de Venise* products. Their unquestionable transalpine origin has been confirmed by finds recorded in the remains of glasshouses, e.g., in manufacturing refuse of the 17th-century The Two Roses glassworks in Amsterdam.[78] A more precise determination of the artefacts' provenance requires the application of archaeometric analyses, which are based on differentiating the raw materials used in the production process. In many cases, they make it possible to distinguish vessels that resemble Venetian wares, or share some of their characteristic features, from genuine Venetian glass.[79] In addition to the ones mentioned above, samples of several items, including those found in Brno,[80] Elbląg,[81] and Tarouca/Lamago,[82] have also been subjected to such analyses.

The data collected and presented above suggest that ice glass is relatively rare among archaeological finds and is infrequently mentioned in monographs of sites or studies focused on glassware collections. The latter are especially significant because they encompass materials from larger territories (regions, countries).[83] The author's observations align with those of other researchers, who, regarding Baden-Württemberg,[84] the Czech lands (including Silesia),[85] Scandinavia,[86] and the British Isles,[87] note that these are rare artefacts, though not entirely unrecorded. While the conclusions about the artefacts from southern Germany and the Czech lands remain relevant, the two remaining opinions were published over two decades ago. Therefore, it cannot be ruled out that the perception of the low prevalence of ice glass in Scandinavia and Britain may have changed somewhat since then, given the increase in archaeological sources registered (especially unpublished finds) and the development of research on early modern glass.

The small number and scattered nature of the finds necessitate further analysis in future research. There could be several reasons for this situation. In addition to factors related to the scope of early modern production, distribution, and the cost of purchasing such items, another significant consideration might be a more contemporary, 'human' factor — the difficulty in identifying ice glass, particularly among glass sherds. Small fragments, as well as corroded ones, may be mistaken for heavily damaged and deformed pieces due to post-depositional processes, especially given their specific surface texture. Expertise and familiarity with glass featuring such decoration seem crucial for accurate identification.

Ice glass from the Tykocin Castle

This relatively small archaeological assemblage is supplemented by ice glass sherds discovered during excavations at the Tykocin Castle, located in north-eastern Poland, in the Podlaskie Voivodeship (Fig. 6). The finds gave me the impulse to further explore the subject of ice glassware.

The castle was located on an island on the Narew River, opposite the town of Tykocin. In the modern period, it was an important centre in both the region and the whole Polish-Lithuanian Commonwealth. The form and functions of the complex evolved over time. As a fortified masonry structure, it functioned from the third quarter of the 16th century to the 1760s. It was still used, albeit in a deepening state of disrepair and ruin, in the first half of the 19th century. Before 1661, the fortress belonged to the Polish kings, being managed by starosts. Then, it became private property, first of military commander Stefan Czarniecki and subsequently of the influential Branicki family (of the Gryf coat of arms).[88]

The site was explored during the excavations conducted in 1961–1963 and 2001–2007, resulting in many important discoveries concerning the castle's architecture, as well as the recovery of numerous and diverse artefacts dating from the 15th to 20th century, including a total of 6,912 glass sherds.[89] Among these, window glass predominates, while glass vessels represent a smaller percentage (1870 fragments, 27%), with bottle fragments of various sizes and forms outnumbering the others.

[76] Tausendfreund 2014b, 76, no. 737; Tausenfreund 2014a, 168.
[77] Lazar and Willmott 2006, 17.
[78] E.g., Hulst et al. 2012, 353.
[79] See Kunicki-Goldfinger 2021, 20.
[80] Sedláčková and Rohanová 2016, 164, no. BoMe2_17-284; 269, table 6:A059.
[81] Kunicki-Goldfinger et al. 2008, 309, table 1, sample 174; Kunicki-Goldfinger 2021, 23, table 1, no. 1.
[82] Coutinho 2016, 306, table VII.1, SJT0112; 309, table VII.2; Medici et al. 2017, 415, fig. 3, SJT0112; 417.
[83] Cf. mostly Coutinho 2016; Reppo 2024; Ring 2003; Rohanová et al. 2024; Tausendfreund 2014a; Tausendfreund 2014b;; Willmott 2002.
[84] See Röber 2022, 243.
[85] See Rohanová et al. 2024, 195.
[86] Haggrén 2000, 40.
[87] Willmott 2002, 31, 41; Willmott 2004, 276.
[88] Bis and Bis 2015a; Bis 2023, 200.
[89] Bis and Bis 2015a.

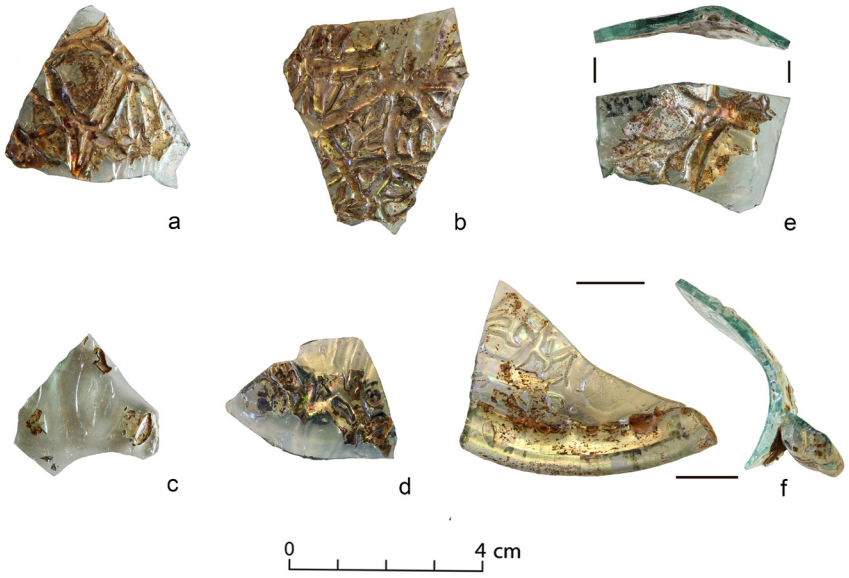


Fig. 6. Ice glass from the Tykocin Castle (Poland) from the 17th century: a-b – beakers; c-d – goblets; e – bucket; f – lid. Photo: W. Bis. Graphic design: M. Bis and W. Bis.

Most of the glassware, including ice glass, originates from the layers dated to the period between the second half of the 17th and the second half of the 18th century.[90] It was recovered in 2003 in trench 18, located in the northern part of the complex, outside the external line of castle buildings, in the layer backfilling the remains of a roundel, an element of the Renaissance defensive system. The finds were retrieved from the junction of two layers (nos. 03 and 04). The second layer contained a deposit of windowpane fragments, dating probably from the 1660s.[91]

A total of six ice glass vessel fragments were retrieved. Their detailed description is presented in Table 1. The glass finds were subjected to macroscopic analysis and examined under a magnifying glass, following the guidelines and descriptions outlined in Polish literature for this type of post-medieval artefacts.[92]

These are incomplete glass objects — small sherds (measuring approx. 6–14 cm²), all originating from the bellies of vessels, with one exception: a fragment with the preserved edge and recess. These are likely the remains of two beakers, two goblets, one lid, and one bucket (Figs. 6-7). The thickness of the glass ranges from 0.5 to 2 mm, with the bucket fragment being the thickest (1-2 mm). The outer surface of all fragments is partially corroded, evidenced by a golden-brown iridescent layer that flakes away and the formation of crusts. The corrosion (weathering) process was accelerated by unstable environmental conditions during deposition in the ground and subsequent storage after excavation.[93] For this reason, the observation of production process traces was somewhat challenging. The glass was determined to be colourless, with a slight greenish tinge and good clarity. It contains small, generally oval bubbles, occurring either singly or in small clusters, with an irregular distribution. The fragments are from free-blown glassware. The ice-like texture covering the outer surfaces of the beakers, lid, and bucket is highly pronounced and dense. However, the texture is finer and more superficial on the two goblet fragments, applied over moulded ornament. No traces of additional decoration were observed on the recovered fragments.

Based on the results of the SEM-EDS (Scanning Electron Microscopy – Energy Dispersive Spectroscopy) analysis, the elemental chemical composition of glass was determined (Table 2). The research was conducted on three samples – from the two beakers (CL 22639 and 22640) and the bucket (CL 22638). A total of six analyses were performed, two for each sample, on small glass fragments, on vessel cuts.[94]

[90] Bis 2022, 99-102; see also Bis 2014.

[91] Bis 2019.

[92] According to Olczak 1983, 121-123; Rubnikowicz 1996, 423-426; Nawracki 1999, 60-62. The analysis focused on the formal features of the examined artefacts, including: their shape, edge type, state of preservation, metrical and morphological characteristics of the material, surface structure properties, and evidence of processing or manufacturing activities.

[93] See Davison 2006, 183-198; Sedláčková and Rohanová 2016, 228-229.

[94] The research was carried out at the Laboratory of Bio- and Archaeometry of the Institute of Archaeology and Ethnology Polish of the Academy of Sciences in Warsaw. They were performed by Mateusz Słoniewski, MA. Samples were mechanically cut out. A Tescan Vega GMS scanning electron microscope (S5153) was used, with a detector from the AZtec Live Advanced series, UltimMax 40 series EDD X-ray microanalysis system. The spectra were acquired for 100 s with a beam current of 5 nA and at a voltage of 20 kV. A total of 18 elements were determined during the analyses. Their level of detection was mostly 0.02-0.03 wt%, with the lowest being 0.08 wt% for SiO_2.

Table 1. Characteristics of the analysed 17th-century ice glass from the Tykocin Castle (Poland).

No	Inventory number	Laboratory number	Type of glass vessel	Part of glass vessel	State of preservation	Dimensions (mm)			Colour of glass	Description	Figure
						Size	Thickness	Diameter			
1	Tn.Z. 18.03_1	CL 22639	beaker	body	fragment; outside: iridescence on large part of surface	ca. 40×35	0.7-1.0	-	colourless, greenish tint	glass: thin; profile: slightly folded; outside: rough surface - clear net of frosted glass; inside: smooth surface; in glass: no glass defects	6:a; 7:c
2	Tn.Z. 18.03_2	CL 22638	bucket	body (upper part)	fragment; outside: iridescence on small part of surface	ca. 33×25	1.0-2.0	-	colourless, greenish tint	glass: thicker; profile: curved, with a folded edge, obtuse angle; outside: rough surface - clear net of frosted glass; inside: smooth surface; in glass: few small glass bubbles	6:e; 7:f
3	Tn.Z. 18.03_3	-	goblet	body	fragment; outside: iridescence on a small part of surface	ca. 25×25	0.5	-	colourless, greenish tint	glass: thin and fragile; profile: slightly folded; outside: rough surface but delicate, frosted glass over moulded pattern; inside: smooth surface; in glass: single small glass bubbles	6:c; 7:d-e
4	Tn.Z. 18.04_1	CL 22640	beaker	body	fragment; outside: iridescence on entire surface	ca. 30×40	0.8-1.0	-	colourless, greenish tint	glass: thin; profile: slightly folded; outside: rough surface - net of frosted glass; inside: smooth surface; in glass: no glass defects	6:b; 7:c
5	Tn.Z. 18.04_2	-	goblet	body	fragment; outside: iridescence on a small part of surface	ca. 25×30	0.7-1.0	-	colourless, greenish tint	glass: thin; profile: slightly folded; outside: frosted glass over moulded pattern; inside: smooth surface; in glass: single, small glass bubbles	6:d; 7:d-e
6	Tn.Z. 18.04_3	-	lid	body, edge, vertical lip inside	fragment; outside: iridescence on a small part of surface	ca. 40×27	0.6-1.0	110 (of the edge)	colourless, greenish tint	glass: thicker; profile: domed; outside: rough surface - clear net of frosted glass; inside: smooth surface; in glass: single small glass bubbles	6:f; 7:a-b

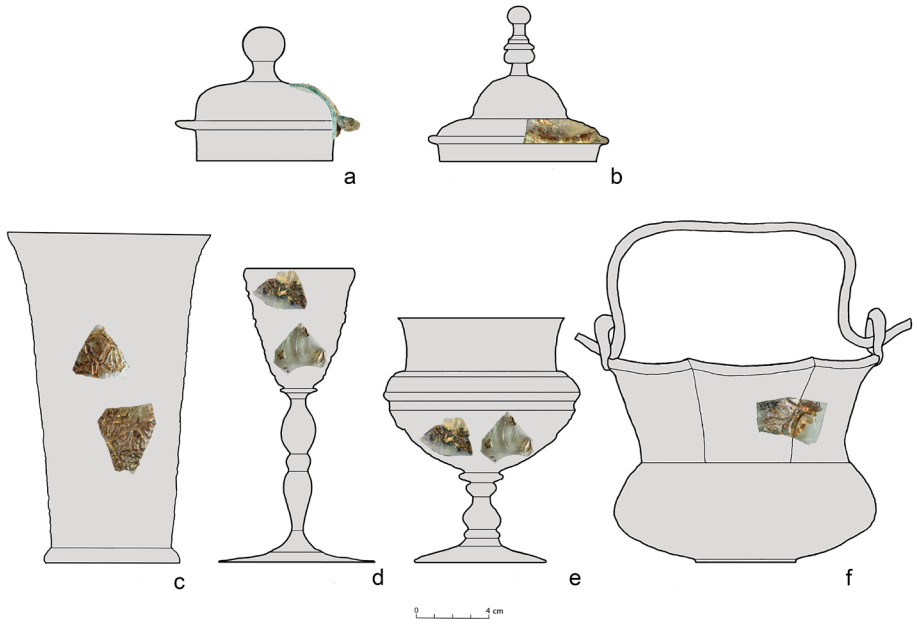


Fig. 7. Ice glass from the Tykocin Castle (Poland) from the 17th century. Reconstruction of possible forms (based on museum exhibits): a-b – lids; c – beaker; d-e – goblets; f – bucket. Drawing: E. Gumińska. Graphic design: M. Bis and W. Bis.

The glass was identified as calcic, specifically of the calco-potassic (Si-K-Ca) type,[95] as the total alkali content (K_2O+CaO) exceeds 22% wt., ranging from 24.36 to 27.98%.[96] Characteristic features of this glass type are: the very low sodium (Na_2O) content, not exceeding 0.5%, while the potassium (K_2O) concentration ranges between 8.45% and 9.65%; the SiO_2 concentration falls between 50% and 63% (in the Tykocin samples: 61.8–63.9% wt.); the CaO/K_2O ratio exceeds 0.5, with the sum of Na_2O and K_2O being less than 10% (in the Tykocin samples: 4.42–4.92%), which is countered by the low CaO content, below 20%[97] (in the Tykocin samples: 15.9–18.3%). The results suggest that this glass type might have been manufactured, using sand and a mixture of beech (Ca-rich) and fern ash (K-rich). Chemically, the analysed glasses closely resemble those from western France dating to the 1600–1700 period.[98] While this is a preliminary conclusion, requiring further research, particularly involving trace element analyses, it points to Western Europe being a potential production site for the analysed ice glass (*à la façon de Venise*).

Due to the state of preservation, the form of the ice glass beakers and goblets cannot be accurately reconstructed. However, the shape of the fragments suggests that the beakers were oval (Fig. 7:c), while the goblets had a conical or rather wide form (Fig. 7:d-e). By analogy, it can be assumed that the former were likely slightly flared, and the latter bulbous. Such objects are abundantly represented in museum collections[99] and, in the case of beakers, are also found among archaeological artefacts from sites in various countries.[100] The ice glass pattern over the moulding decoration of the goblets appears to be analogous to an object in the RM collection (Fig. 4:a).

The shape of the lid fragment indicates that the item had a hemispherical form (Fig. 7:a–b), with an edge diameter of 11 cm. It features a part of a keyway (vertical lip) on the inside, designed to fit into the rim of the vessel. The lid handle is not preserved, but similar specimens show that it was likely a finial formed from a flattened knob. Domed lids are found among Venetian objects in museum collections, but they are infrequently recorded in published archaeological assemblages.[101]

[95] According to Schalm et al. 2004.

[96] Values refer to average concentrations (in Tab. 1 as mean).

[97] Černá et al. 2023, 125-126.

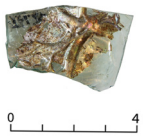
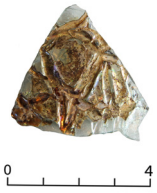
[98] In terms of content, CaO/(CaO+K_2O) – 0.65 (indicated range of 0.4–0.8) and MgO content of 3.43–4.1% (2.6–8.0%), but with lower concentration of Na_2O (0.2–0.39%) than designated (0.5–3.4%), Janssens et al. 1998, 258-261.

[99] E.g., beakers: in the Kunstmuseum Den Haag – object no. 1004708 (https://www.kunstmuseum.nl/en/collection/beaker-2; available on-line 03.11.2024); in the RM – object BK-KOG-112 (https://www.rijksmuseum.nl/nl/collectie/BK-KOG-112; available on-line 29.10.2024); in the BM – object no. S.700 (https://www.britishmuseum.org/collection/object/H_S-700; available on-line 28.10.2024); in the MET – accession no. 1975.1.1149 (https://www.metmuseum.org/art/collection/search/460886; available on-line 14.10.2024); goblets: in the CMoG – objects nos. 79.3.188 and 79.3.187 (https://glasscollection.cmog.org/objects/14819/goblet; https://glasscollection.cmog.org/objects/14374/goblet; available on-line 29.07.2024).

[100] E.g., beakers found in Bergen, Haggrén 2000, 40, fig. unnumbered; Beverwijk, Hulst and Weber 2012, 435, fig. 9; London, Willmott 2002, 41, no. 1.11; Lüneburg, Ring 2003, 92, no. 2.041; Bocholt, Höxter, Münster, and Reine, Tausendfreund 2014a, 101-103; Tausendfreund 2014b, 19-20, nos. 165-166; 159, no. 1586; 253, nos. 2606-2610.

[101] E.g., lid from the Gnalić wreck; its rim diameter is 13.3 cm, Lazar and Willmott 2006, 46, no. S12a; lids from different sites in England, Willmott 2002, 73-75, and in Austria, Sedláčková and Rohanová 2016, 65, fig. 96; 79, fig. 125.

Table 2. Composition of 17th-century ice glass from the Tykocin Castle (Poland) as determined by SEM-EDS method (wt.%).

SAMPLE	PICTURE	TRANSPARENCY, COLOUR OF GLASS	ANALYSIS	SiO_2	Na_2O	K_2O	CaO	MgO	Al_2O_3	Fe_2O_3	MnO	P_2O_5	Cr_2O_3	CuO	TiO_2	ZnO	SO_3	OTHER COMPONENTS*
CL 22638		translucent; colourless, greenish tint	**1**	62.4	0.31	9.36	17.6	3.56	1.57	0.51	0.21	3.81	0.23	<	0.16	0.05	0.23	<
			2	62.5	0.26	9.34	17.6	3.58	1.55	0.47	0.23	3.82	0.27	<	0.12	0	0.21	<
			mean	62.5	0.29	9.35	17.6	3.57	1.56	0.49	0.22	3.82	0.25	<	0.14	0.03	0.22	<
CL 22639		translucent; colourless, greenish tint	**3**	61.5	0.2	9.76	18.6	3.37	1.52	0.52	0.23	3.71	0.23	0.04	0.12	<	0.16	<
			4	62	0.2	9.53	18.1	3.49	1,6	0.52	0.22	3.74	0.25	0	0.12	<	0.18	<
			mean	61.8	0.2	9.65	18.3	3.43	1.56	0.52	0.22	3.73	0.24	0.02	0.12	<	0.17	<
CL 22640		translucent; colourless, greenish tint	**5**	64.2	0.44	8.23	15.5	4.2	2.02	0.43	0.17	4.11	0.21	0.06	0.12	<	0.32	<
			6	63.6	0.34	8.67	16.3	4	1.72	0.46	0.17	4.02	0.25	0	0.12	<	0.28	<
			mean	63.9	0.39	8.45	15.9	4.1	1.87	0.45	0.17	4.07	0.23	0.03	0.12	<	0.3	<

* PbO, NiO, As_2O_5, PbO, ZrO_2 – components performed in every analysis but not present in glass or with low concentration, below the detection point for this method ("<")

This also applies to the items with ice glass pattern surfaces. The vaulted lids are held, for example, in the Heylshof Museum in Worms[102] and in the Veste Coburg Museum;[103] a similar artefact was excavated in Ulm, Germany.[104] Glass vessels decorated with crackle textures were also supplied with metal lids, such as pewter.[105]

The bucket is an interesting item within this assemblage. The discovered fragment comes from the middle part of a rim, at the bend of the glass wall, where it forms an obtuse angle (approximately 140°) (Fig. 7:f). This feature suggests the rim may have been multi-sided and created using a fin mould. An analogous specimen, with an octagonal rim, dated to the 17th century, made in Venice, is in the CMoG's collection.[106] Other buckets in museum collections typically only have a slightly flared rim, with no moulding, and conical sides, rising from a bulbous bowl to the rim.[107] One fragment of a body discovered on the Gnalić wreck was considered to be part of a basket (bucket), especially as a twisted glass handle for such a vessel was also recovered there.[108] It is dated to around the 1580s.

Due to the small size of the fragment, there is no basis for determining the size of the entire Tykocin vessel, so various potential uses can be considered. Smaller buckets may have served as containers for holy water (aspersoria) in places of individual worship in private indoor spaces.[109] Such a hypothesis regarding the use of the object raises a series of questions about the functions of the Tykocin complex and the religious practices carried out within its walls. Unfortunately, these questions cannot be resolved due to insufficient written sources. It is assumed that similar items, though slightly larger in size, could have also served as handwashing utensils for ecclesiastical and secular interiors[110] or cooling bowls. In my opinion, it cannot be ruled out that they were employed, for example, as receptacles (glass vases) for bouquets of flowers. Such use is indicated by iconography from the period – still life paintings with plants in various vessels, including glassware.[111]

Whom might the described objects have belonged to? The stratigraphic context of the finds indicates that they can be dated to the second half of the 17th century or possibly slightly earlier – around the middle of the 17th century. At this time, the castle not only had military significance but also occasionally served as a high-status residence, functioning as the centre of an estate and the seat of its steward. The number of its residents and the social composition of the group varied.[112] A particularly significant period in the castle's history was the Second Northern War (1655–1660), during which much of the structure was destroyed. Written sources confirm that various notable figures stayed there at that time, including Swedish commanders Wilhelm Block and Erich Drake, magnates and Polish military leaders Paweł Sapieha and Stefan Czarniecki, princes Bogusław and Janusz Radziwiłł.[113] It seems, however, that such fragile and ornate glassware was unlikely to have formed a part of wartime tableware equipment.

The person who might have owned such precious items and brought them to the Tykocin Castle was Prince Janusz Radziwiłł (1612–1655), one of the wealthiest magnates in the Polish-Lithuanian Commonwealth of the period. He arrived at the end of 1655, bringing many of his valuable possessions with him, including metal tableware, weapons, textiles, and clothing, as confirmed by written sources.[114] He stayed for about two weeks to prepare the fortress for defence but died there in the night between 30 and 31 December 1655.[115] Among the items left behind by him and stored in the castle, the 1656 inventory lists, among others, three vessels described as 'crystal': a flask, a goblet, and a small glass, with the first two featuring metal elements.[116] Could it have been ice glass? Maybe, especially since the term used in the inventory referred to high-quality, colourless, *cristallo*-type glass. Destroyed during the military offensive on

[102] Object no. Sw 809, dated: probably 17th century, provenance: Venice, https://rlp.museum-digital.de/object/86826 (available on-line 24.10.2024).

[103] Inventory no. HA 545, *à la façon de Venise* object, dated: 17th century, Theuerkauff-Liederwald 1994, 168, no. 153.

[104] Röber 2022, 243, 255, plate 10:241.

[105] Brüderle 2013, 63.

[106] Object no. 2000.3.5, https://glasscollection.cmog.org/objects/64628/aspersorium (available on line 28.07.2024).

[107] In the J. Paul Getty Museum – object no. 84.DK.657, dated: 1550-1600, provenance: Italian or Netherlandish, https://www.getty.edu/art/collection/object/103RPN#full-artwork-details (available on-line 27.10.2024); in the Veste Coburg art collection – Inventory no. HA 555, dated: 2nd half of the 16th century, provenance: Venice or *façon de Venise*; Inventory no. HA 554, 2nd half of the 16th century-17th century, *façon de Venise*, Theuerkauff-Liederwald 1994, 525-526, nos. 678-679; see also bowls of similar shape, Inventory nos. HA 550, HA 551, HA 556, dated: 1st half of the 17th century (HA 556) or 2nd half of the 17th-beginning of the 18th century (HA 550, 551), made in Venice, Theuerkauff-Liederwald 1994, 130-132, nos. 87-89.

[108] Lazar and Willmott 2006, 66, nos. S26e-f; 133, plate 25:5 (handle), 25:6 (basket).

[109] Gudenrath 2016.

[110] See Theuerkauff-Liederwald 1994, 525.

[111] Cf. e.g., the paintings in the RM, https://www.rijksmuseum.nl/en/rijksstudio.

[112] Bis 2023, 201.

[113] Bis and Bis 2015b, 55-57.

[114] Cf. Regestr 1656; Kotłubaj 1859, 431-436.

[115] Bis 2023, 106.

[116] *Regestr* 1656, 3.

27 January 1657, this glassware may have been discarded during subsequent clean-up in the 1660s. This remains one possible hypothesis.

Conclusions

Ice glass – *vetro ghaccio* – represents the mastery of the Renaissance Venetian artisans and the development of the glass industry, with a focus on creating innovative and high-quality objects.[117] Its deliberately transformed surface became a sought-after ornamental effect. The demand for such pieces has led to the emergence of creative imitations of genuine items in various parts of the continent from the 16th century onwards.

Proof of the formal and stylistic diversity of early modern ice glass production can be found in specimens preserved in many museum collections. As evidenced by the presented data, such glassware is less frequently recorded in the archaeological materials from most European countries. A slightly higher number of archaeological finds have been identified in present-day Czechia, Germany, and the Netherlands. Beaker finds from the first half of the 17th century predominate.

In this context, the artefacts from the Tykocin Castle (six fragments) are worth noting. Based on foreign archaeological finds and literature, the possible form and function of the vessels were identified. Three of these represent the main types of ice glass: slightly flared beaker, conical goblet, and domed lid intended to cover one of the previous items. These vessels were likely used for drinking. The last fragment probably comes from a bucket with a polygonal-shaped lip. It may have been used as a cooling bowl or served possibly for private devotion. Undoubtedly, this is a rare object. The striking appearance of the described items also made them suitable for display.

The results of archaeometric analyses, which allowed us to determine the glass type (potassium-calcium glass, Si-K-Ca), combined with the morphological and technological features, suggest that the vessels found at the Tykocin Castle represent *façon de Venise*. They likely originated from Western European glassworks (possibly located in western France or in the Netherlands) that achieved a high level of production using local raw materials with their designs inspired by the finest works of Italian glassblowers. Further laboratory analyses, particularly those involving trace element examination, seem to offer the best opportunity for refining the provenance of these items.

The artefacts likely date from before 1655. Based on the available historical evidence, a potential owner of the items could have been Prince Janusz Radziwiłł. He arrived at Tykocin Castle in late 1655 in the Second Northern War, bringing with him many valuable personal belongings, including three crystal glassware. Some of these items were destroyed along with the building during the siege in 1657. In the following decade, broken glass may have been thrown outside the castle walls through restoration works.

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[117] See Burkart 2021, 36.

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