Hellenistic mosaic glass vessels in Bohemia and Moravia

Helenistické mosaikové skleněné nádoby v Čechách a na Moravě

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Imported artefacts from the Late La Tène period also include mosaic glass vessels produced using millefiori, reticella and ribbon mosaic glass techniques. The artefacts are part of the assemblages from the oppida of Stradonice and Staré Hradisko and from the Jičina-Požaha hillfort of the Púchov culture. Their origin can be traced to a Hellenistic workshop(s) in the eastern Mediterranean that was probably in operation in the second and first centuries BC. According to their chemical composition determined by means of SEM-EDS, NAA and LA-ICP-MS, the chemical type of glass of the mosaic vessels is the same as the glass used to make La Tène ring ornaments – soda-lime natron glass.

mosaic glass vessels – Late La Tène period – Mediterranean imports – archaeometry

Importované předměty z mladší doby laténské zahrnují také skleněné nádoby zhotovené technikami millefiori, reticella a technikou páskového (achátového) skla. Tyto artefakty jsou obsaženy v kolekcích z oppid Stradonice a Staré Hradisko a z hradiště púchovské kultury Jičina-Požaha. Pocházejí z helenistické dílny či dílen, pracujících ve východním Středomoří ve 2. a 1. století př. Kr. Podle chemického složení, zjištěného pomocí analýz SEM-EDS, NAA a LA-ICP-MS, se chemický typ skla mosaikových nádob shoduje se sklem použitým k výrobě laténského kruhového šperku. V obou případech jde o sodno-vápenaté natronové sklo.

nádoby z mosaikového skla – mladší doba laténská – středomořské importy – archeometrie

Introduction

In addition to common La Tène glass ornaments such as bracelets, finger rings, beads and spacers, the inventory of La Tène finds in Europe also includes a small number of glass vessels which were undoubtedly luxurious imported goods. The vessels were small polychrome cups that were evidently part of drinking sets.

Based on La Tène period finds from Bohemia and Moravia, this paper addresses Hellenistic polychrome vessels made using a mosaic technique in which prepared polychrome components are fused together. Appearing among the studied material are vessels produced using the techniques of reticella (composed of twisted threads), millefiori (from the sections of polychrome canes and/or from monochrome tesserae) and band/onyx-mosaic glass (with inserted bands, in some cases even gold: gold-band glass). As will be shown below, these are Hellenistic products that were imported into La Tène Europe.

Polychrome (mosaic) vessels in La Tène Europe have not received adequate attention to date. *J. Meduna* (*1961*; *1970*; *1974*) listed and briefly summarised finds from Moravia. The first list of imported glass vessels from the 'La Tène III' period (*Berger – Jouve 1980*, 13) recorded mosaic glass from only five sites. *N. Venclová* (*1990*, 159–162) registered sporadic finds from Stradonice. *R. Gebhard* and *M. Feugère* (*1995*) studied objects found at Manching

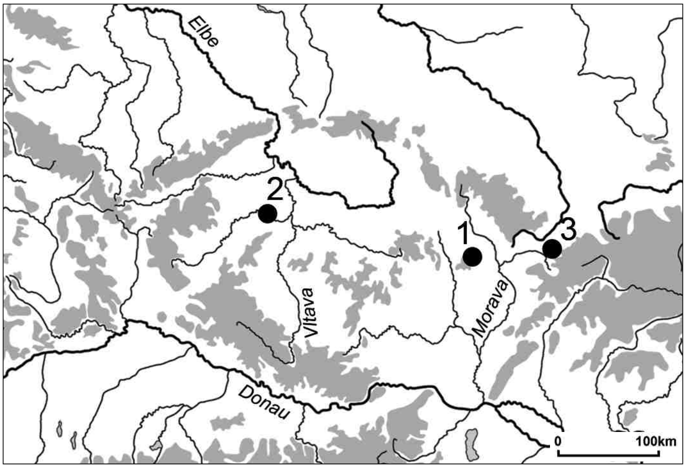

Fig. 1. Hellenistic mosaic glass vessels in Bohemia and Moravia. 1 Staré Hradisko, 2 Stradonice, 3 Jičina–Požaha.
Obr. 1. Helenistické mosaikové skleněné nádoby v Čechách a na Moravě. 1 Staré Hradisko, 2 Stradonice, 3 Jičina–Požaha.

in 1955–1972, while *A. S. Bride* (*2005*) compiled and classified the collection acquired up to 2001 from Mont Beuvray.

Find context of vessels

Due to the fact that in the vast majority of cases amateur finds made years ago of artefacts originating in the classical world are concerned, their find context is important for ruling out the possibility that they are antiquarian items whose local findplace could be called into question. The truth is that museum collections may contain artefacts under the designation of 'Stradonice' and 'Staré Hradisko' (the main sites of interest in this paper) that clearly have a different origin.

Among their finds from the Staré Hradisko oppidum, *F. Lipka* and *K. Snětina* (*1912*, 86) explicitly mention fragments of vessels from millefiori glass (held today at the Museum in Boskovice). This means that they could not have become part of the museum collection at a later date, e.g. from a private collection, which would cast doubt on their provenance. As the lone fragment from the Museum in Prostějov probably comes from the same vessel as one of the fragments in the Boskovice Museum, the same logic applies to it as well. Another fragment comes from a modern excavation and was discovered in a La Tène settlement feature (see below). Therefore, there is no doubt about the origin of the mosaic vessels from the La Tène oppidum of Staré Hradisko.

Fragments of mosaic vessels from the Stradonice oppidum held at the National Museum in Prague and labelled 'd' come from the Stradonice collection of Štěpán Berger purchased for the National Museum in 1898. An inventory of these fragments was compiled in 1913 (*Valentová 2013*, 18, 21–24). A fragment held at the Museum of Natural History in Vienna was part of the collection of the director of the Fürstenberg ironworks (located near the Stradonice oppidum), Vilém Grosse, from the end of the nineteenth century.

It is not likely that the small fragments from either of the oppida came from elsewhere and were added to the museum collections at a later date, as Hellenistic mosaic vessels remain quite rare in the classical world finds to this day, let alone at the beginning of the twentieth century. Moreover, small and typically corroded fragments are not especially attractive at first glance.

The other findplace, the Jičina-Požaha hillfort of the Púchov culture (LT C2-D2), was professionally investigated in the second half of the twentieth century, and there is no doubt about the origin of the mosaic vessel fragment from that location.

List of Hellenistic mosaic glass vessels in Bohemia and Moravia

The mosaic vessels known to date from the three La Tène sites (*fig. 1*) are listed in order based on the number of finds. Vessel numbers correspond to those used in *fig. 2* and *3*. Samples: chemically analysed sample no. are given. Abbreviations: D – mouth diameter, M – Museum.

1. Staré Hradisko (comm. Malé Hradisko, Prostějov district)

La Tène hillfort – oppidum, LT C2-D. Unstratified finds come from the early excavations of F. Lipka and K. Snětina (held mostly at the museum in Boskovice) and from private collections (held in the Prostějov museum); one stratified find was obtained during the excavations conducted by M. Čižmář (held at the Moravian Museum in Brno). Some of the artefacts were published, sometimes without a description and illustration, in catalogues compiled by *J. Meduna* (*1961*, 55; *1970*, 87).

Millefiori glass

1. Bowl rim (*fig. 3*): rounded rim made from spirally wound cobalt blue and white threads; visible in the wall immediately below the rim is a yellow and colourless motif (a flower?); a very small fragment. Max. wall thickness 3.5 mm. Excavation by M. Čižmář in 1986, square KB 46, hut 3/86-J. Moravian Museum in Brno inv. no. 09050-1984/86a. Unpublished.
2. Vessel wall (*fig. 3*): white-blue spirals with a yellow centre (perhaps from vessel no. 8?). Max. wall thickness 2.5 mm. Prostějov Museum inv. no. M265/21-36517. *Meduna 1970*, 87, Tab. 12: 8. Sample 629.
3. Bowl rim (*fig. 2*): straight, tapered walls, a rounded rim made from a spirally wound cobalt blue and white thread; in the wall are yellow-blue spirals and a cobalt blue tessera with a white stripe (from the same glass as the rim?) visible from both sides. D of bowl 125 mm, max. wall thickness 3 mm. Boskovice Museum inv. no. 602-2109. *Meduna 1961*, 55, Tab. 50: 9. Samples 646, 703, 704.
4. Bowl rim (*fig. 2*): straight, open walls, a rounded rim, white-violet concentric rings and yellow-dark blue-turquoise flowers with a white centre. D of bowl 100 mm, max. wall thickness 2 mm. Boskovice Museum inv. no. 602-2110. *Meduna 1961*, 55, Tab. 50: 8. Samples 705, 891, 892.
5. Vessel wall (*fig. 3*): curved wall, white-violet concentric rings and honey brown-white flowers. Wall thickness 2–2.5 mm. Boskovice Museum inv. no. 602-2112. *Meduna 1961*, 55. Samples 647, 702.
6. Vessel wall (*fig. 3*): curved wall, yellow-dark blue spirals and bluish-green elements (colours blurred), a yellow and light green tessera visible from both sides. Max. wall thickness 3 mm. Boskovice Museum inv. no. 602-2113. *Meduna 1961*, 55. Samples 706, 893, 894.
7. Vessel wall (*fig. 3*): slightly curved wall composed of tesserae: opaque yellow and white, translucent violet, cobalt blue, light blue and green, visible from both sides. Wall thickness 1–1.5 mm. Hellenistic or modern? Boskovice Museum inv. no. 602-2114. *Meduna 1961*, 55. Samples 707, 895, 896, 897.
8. Vessel wall (*fig. 3*): white-blue spirals with a yellow centre (perhaps from vessel no. 2?). Max. wall thickness 3 mm. Boskovice Museum inv. no. 602-2115. *Meduna 1961*, 55.

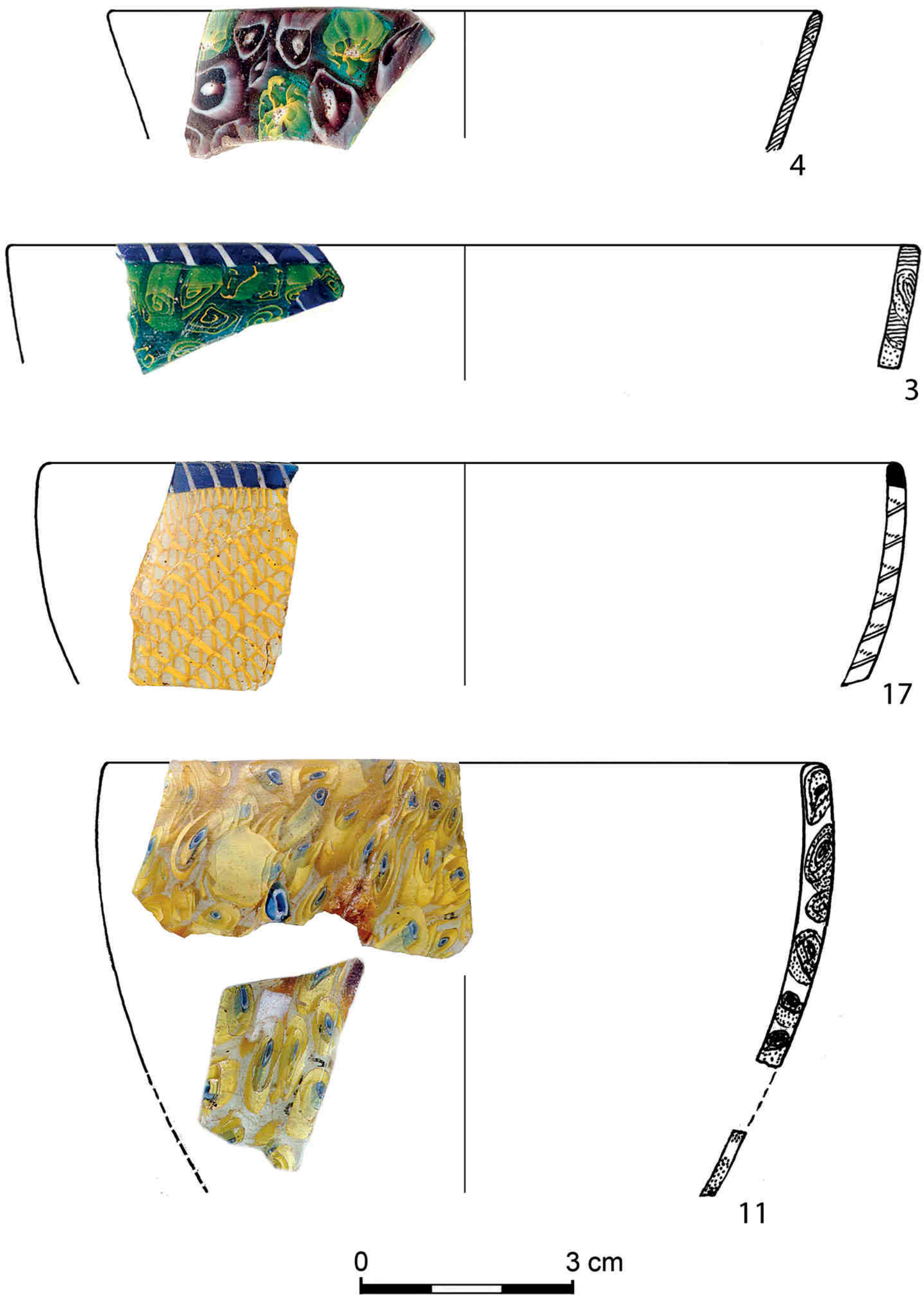

Fig. 2. Reconstructed Hellenistic mosaic glass vessels. Moravia. Numbers correspond to vessel numbers in the List of Hellenistic mosaic glass vessels in Bohemia and Moravia, pp. 215, 218. Photo H. Toušková.
Obr. 2. Rekonstruované helenistické mosaikové skleněné nádoby. Morava. Čísla odpovídají číslům nádob v soupisu na str. 215, 218.

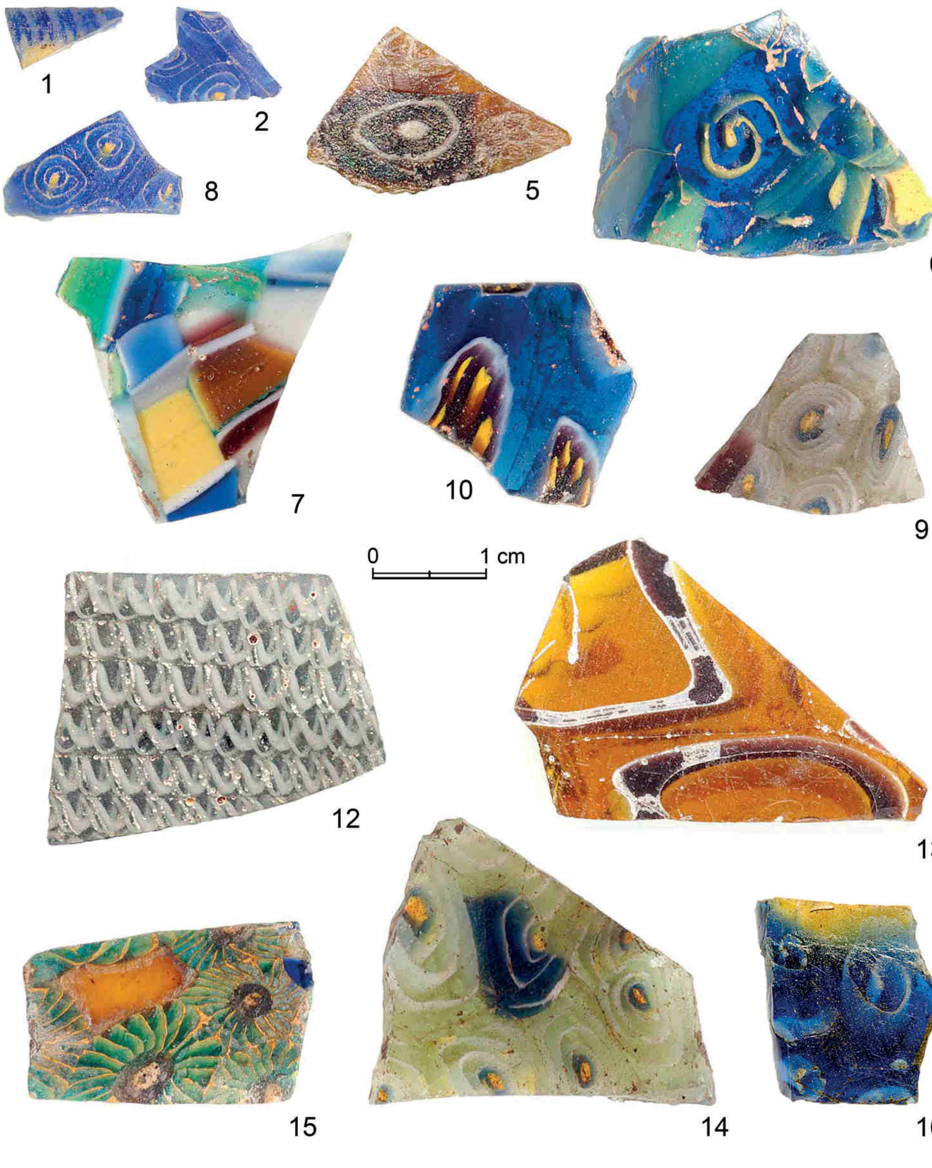

Fig. 3. Hellenistic mosaic glass vessels in Bohemia and Moravia. Numbers correspond to vessel numbers in the List of Hellenistic mosaic glass vessels in Bohemia and Moravia, pp. 215, 218. No. 7: dating disputable. Photo H. Toušková, no. 16 Museum of Natural History in Vienna.
Obr. 3. Helenistické mosaikové skleněné nádoby v Čechách a na Moravě. Čísla odpovídají číslům nádob v soupisu na str. 215, 218. Č. 7: datace sporná. Č. 16 Naturhistorisches Museum in Wien.

9. Vessel wall (*fig. 3*): slightly curved wall, white-colourless spirals with a yellow-blue centre, violet tessera visible from both sides. Wall thickness 3 mm. Boskovice Museum inv. no. 602-2118. *Meduna 1961*, 55. Samples 708, 898.
10. Vessel wall (*fig. 3*): straight wall, white-yellow-violet flowers with a white centre, on a blue field. Wall thickness 1.5–2.5 mm. Boskovice Museum inv. no. 602-2119. *Meduna 1961*, 55. Samples 709, 785, 899.
11. Eight bowl fragments (*fig. 2*): rounded rim, curved walls, yellow-colourless spirals with a blue-white centre; honey brown and white tessera visible from both sides. D of bowl 100 mm, wall thickness 1.5–4 mm. Boskovice Museum inv. no. 602-2120. *Meduna 1961*, 55, Tab. 50: 7. Samples 641, 642, 643.

Reticella glass

12. Vessel wall (*fig. 3*): slightly curved wall composed of white and colourless twisted threads. Max. wall thickness 1.5 mm. Boskovice Museum inv. no. 602-2111. *Meduna 1961*, 55, Tab. 50: 6. Samples 644, 701.

Ribbon (onyx) glass

13. Vessel wall (*fig. 3*): slightly curved wall, honey brown matrix with violet curved bands, white on the edges. Max. wall thickness 5 mm. Boskovice Museum inv. no. 602-3475. Unpublished. Samples 639, 640.

2. Stradonice (Beroun district)

La Tène hillfort – oppidum, LT C2-D. Unstratified finds from the collections of Š. Berger and V. Grosse from the end of the nineteenth century. Listed in *Venclová 1990*.

Millefiori glass

14. Vessel wall (*fig. 3*): slightly curved wall, white-colourless (greenish) spirals with a yellow-blue centre; cobalt blue tessera visible primarily from the outer side. Wall thickness 3 mm. National Museum Prague, Berger Collection no. 363d. *Venclová 1990*, 159, 304, Pl. 45: 4, 75: 3. Samples 1071, 1134, 1135, 1136.
15. Vessel wall (*fig. 3*): nearly straight wall, flowers with a white-violet centre and yellow-turquoise petals; one yellow and one cobalt blue tessera visible from both sides. Wall thickness 2 mm. National Museum Prague, Berger Collection no. 402d. *Venclová 1990*, 159, 305, Pl. 45: 2, 75: 1. Samples 1072, 1137, 1138, 1139.
16. Vessel wall (*fig. 3*): slightly curved wall, white-blue spirals, honey brown tessera; minute remains of another honey brown tessera and possibly even a white tessera. Wall thickness 2.5–3 mm. Museum of Natural History in Vienna, Grosse Collection no. W 5559. *Venclová 1990*, 159, 312, Pl. 58: 3.

3. Jičina-Požaha (Nový Jičín district)

Púchov culture hillfort, LT C2-D2. Excavations by M. Čižmář in the 1980s. Also erroneously listed in the literature as 'Kojetín'.

Reticella glass

17. Bowl rim (*fig. 2*): rounded rim made from spirally wound cobalt blue and white threads; slightly curved wall composed of yellow and colourless twisted threads. D of bowl 120 mm, wall thickness 2.3–2.8 mm. Nový Jičín Museum inv. no. A 4099, acc. no. 243/76-195. *Čižmář 1996*, 177, Abb. 3: 1.

Cultural and chronological context

Millefiori vessels

Mosaic millefiori glass (from the Italian *mille fiori*, or a thousand flowers) was composed of polychrome canes produced by various techniques (on the production techniques of canes, see *Stern – Schlick-Nolte 1994*, 55–63); upon completion, the canes were reheated, pulled to the necessary diameter (c. 5 mm) and cut to sections of the required thickness (c. 3 mm). Depending on the types of canes, their sections produced various patterns, including floral motifs (hence the name) created from a bundle of rods of different colours. Equally common are spirals (the sections of canes made by winding thin sheets around a core of a different colour or without a core), concentric rings (sections of canes with a core wrapped in glass of a different colour) and other patterns. The entire cane was typically cylindrical or even four-sided (the joints between the sections of square canes are visible, for example, on fragment no. 5). Once heated, the outer glass of the canes, which can also be a different colour than its inner polychrome layers creating the decorative motif, fills the space between the individual patterns. Therefore, this is not a matrix, despite the fact that millefiori objects are commonly described in this manner; what is actually being described in these cases is the visual impression of the observer, not the actual technical state of the glass. When the main motif is skilfully executed (spirals, etc.), it appears as if it is lying on a field of a different colour and the joints between the canes are not visible. However, an alternative of cane sections embedded in a matrix glass of different colour cannot be excluded (see vessel no. 10 with no visible joints in the blue glass). Monochrome rectangular segments of glass – tesserae (the name is taken from the cubes of real mosaics) – were also sometimes placed in the wall of the vessel between the sections of canes, usually in contrasting colours; one exception is two-colour tesserae in the same colour scheme as typical blue and white rim bands, apparently cut off from such bands. The typically two-colour, most commonly white and blue, rim bands are shown on vessels no. 3 and 17; nevertheless, millefiori vessels also exist without rim bands (vessel no. 4 and 11).

The following motifs and colours are found in assemblages from Bohemia and Moravia:

- yellow-blue spirals, visual impression: yellowish green spirals on a blue background, because yellow glass appears green beneath the thin layer of blue glass (vessel no. 3)
- yellow-blue spirals and blurred bluish-green elements (vessel no. 6)
- white-blue spirals (vessel no. 16)
- white-blue spirals with a yellow centre (vessels no. 2 and 8 – perhaps fragments of the same vessel?)
- white-colourless (or colourless with a greenish tint) spirals with a yellow-blue centre (vessels no. 9 and 14)
- yellow-colourless spirals with a blue-white centre (vessel no. 11)
- flowers with a white centre and yellow “petals” wrapped in violet and white glass, on a blue field – matrix? (vessel no. 10)
- flowers with a white-violet centre and yellow-turquoise petals; visual impression: the petals appear yellow-green, because yellow glass looks green beneath the thin layer of turquoise glass (vessel no. 15)
- white-violet concentric rings and honey brown-white flowers (vessel no. 5)
- white-violet concentric rings and yellow-dark blue-turquoise flowers with a white centre; visual impression: yellow glass appears green beneath the thin layer of turquoise glass (vessel no. 4)
- indeterminable yellow-colourless element (vessel no. 1).

An exceptional item (Hellenistic or modern?) is a fragment of a vessel wall composed only of tesserae of opaque yellow and white and translucent violet, dark blue, light blue and green (vessel no. 7).

In the studied assemblage, the colour scheme of the canes whose sections create polychrome motifs is opaque white or yellow glass and translucent cobalt blue, bluish-green (turquoise), violet, honey brown or colourless glass. The same colours repeat on the tesserae, and there is also an opaque light green tessera on a fragment of vessel no. 6, perhaps the result of the mixing of yellow and blue glass, as is also evident on the wall beyond the tessera. These and other colour combinations regularly occur in assemblages from the Mediterranean, where patterns such as spirals and flowers also appear. An assemblage from Delos demonstrates the broad colour variability of these elements (*Nenna 1999*, 37–40).

Techniques of millefiori vessel manufacture. Opinions vary on the techniques used to make millefiori vessels. Based on experiments, *S. Goldstein* (*1979*, 30–31, Fig. 6) assumed that segments of canes were set in a concave mould into which a second inner part of a mould was then placed and everything was subsequently heated to fuse the segments. Working with different experiments, *M.-D. Nenna* (*1999*, 40–41) presumes that segments of canes were assembled on a flat disc and then first heated; in the next phase this disc was set on the outer side of a convex mould and heated again. Under its own weight, the disc filled the mould, or 'ran over it'. Known as *sagging* or *slumping* (*Absenken* in German), the origin of this technique is traced to Syro-Palestinian glassworking (*Grose 1984*, 28–30). Based on technical traces and checked glassworking practices, *M. Stern* and *B. Schlick-Nolte* (*1994*, 68–72) accept the use of concave and convex moulds; however, they assume that convex moulds were primarily used for Hellenistic vessels. Suggesting the use of convex moulds are motifs (cane sections) pulled in various ways toward the edge, or the side exposure of canes in places where their segments during the second heating slid over the surface of the mould and were deformed (e.g. vessel no. 11). This is also often confirmed by the joints between cane sections, though apparent always only on the inside of the bowl, which can be matt or uneven from being next to the mould, where it was not smoothed by the heat; the sections were perfectly fused on the outer side. A bicolour band attached to the rim of the bowl was made in advance from two twisted threads or from a white thread spirally wound over dark (blue) rod. Although the rim band could be attached directly to the flat disc in the first phase of production, it is more likely that it was set on the lower edge of the mould in the second phase. The vessel rim could also have been simply ground without the application of a rim band (vessel no. 4, 11). Further experiments suggest that a non-furnace method sufficed for the manufacture of millefiori vessels; a secondary heat resource reaching temperatures of c. 700–800 °C could have been used, possibly even shared among workers of different crafts (*Dawes 2002*). It might not even be possible to archaeologically identify simple equipment of this type.

Typology and chronology. The dating of millefiori vessels is based on several relatively well dated find complexes. Several grave assemblages from Canosa, Italy, represent the earliest group (Canosa) from the period between end of the 3rd century BC and the end of the 2nd century BC (*Harden 1968*; *Oliver 1968*, 48–55). The group includes deeper hemispherical bowls with rounded walls and base, conical bowls and flat plates with everted rim; the vessels have thicker walls than later types (*Nenna 2002*, 153–154, Fig. 1, with refs.). Little is known about this small group. However, it should be pointed out that the dating of the graves from Canosa and the glasses concerned is not clear (*Stern – Schlick-Nolte 1994*, 100), in part because much of the glass was acquired later from private collections and its connection to the relevant graves cannot be certain.

The later group (Antikythera) was named after finds from a shipwreck discovered near the island of Antikythera to the south of the Peloponnese in 70–60 BC (*Davidson Weinberg 1965*; *Oliver 1968*, 55–57; *1981*, 63–66). New information on this group came from glass finds from the island of Delos. With approximately seventy fragments, the assemblage is larger than all of the current mosaic glass vessel finds together. Dated to the period between the end of the 2nd century BC and c. 70 BC, the finds provide a good illustration of this later group known today as Antikythera-Delos (*Nenna 1999*, 50; *2002*, 154). Hemispherical bowls and conical bowls continue and are also joined by shallow forms on a ring-shaped foot, with an upright or everted rim, as well as plates, jars and amphoriskoi (*Nenna 2002*, 154, Fig. 2). Although early and later millefiori vessels do not differ greatly by decorative pattern or colour scheme, in addition to sections of canes the later group can also include segments of large plaques, or walls composed solely of tesserae; a somewhat later trait is the absence of rims in a different colour (*Nenna 1999*, 52). The criterion of tesserae placement is apparently unreliable; according to *Oliver* (*1968*, 65), on hemispherical bowls they should be visible on both sides of the wall, whereas on later flat plates only on the inner side. However, this was not confirmed by recent finds: Delos has produced objects with tesserae that are visible from the inside or outside on the same vessel (*Nenna 1999*, 44).

The manufacture of millefiori vessels also continued in the Augustan and Imperial periods and then up to the fifth century AD using essentially the same or similar technique and colour scheme. New vessel forms include ribbed bowls, patella cups, plates, pyxides and beakers (*Nenna 2002*, 154–155, Fig. 3). Also appearing are different patterns of components-canes from which the walls of vessels are constructed. However, formally non-diagnostic fragments, especially from the bowls of the Augustan period, are difficult to distinguish from those of earlier vessels.

Current inventories contain several dozen sites in the Mediterranean from Italy to the Syro-Palestinian area and in the Black Sea region (e.g. *Oliver 1968*; *Nenna 1999*, Pl. 40); the number of finds continues to grow (e.g. *Nenna 2002*, 154; *Jackson-Tal 2004*, 24).

Reticella vessels

Reticella mosaic glass (network or lacework glass, *Netzwerkglas*) was made out of prepared twisted or spirally wound threads of two colours (for a description of the manufacturing technique, see *Stern – Schlick-Nolte 1994*, 54–55). Since one of the glass threads is translucent and colourless, the thread from the other (opaque) glass ‘floats’ on the background of the colourless glass, producing an impressive lace effect. As is the case with the majority of finds, both Moravian fragments come from bowls with slightly curved walls, one with a rim from twisted cobalt blue and white threads (or a blue cane with a white thread wound spirally around it). The walls are made from white and colourless or yellow and colourless threads twisted in the same direction and set horizontally. The bowl from Jičina–Požaha belongs to medium-large vessels.

Techniques of reticella vessel manufacture. The horizontal arrangement of threads indicates that the vessel was created by spirally winding twisted threads from the rim to the bottom (or in the opposite direction?). Prepared in advance, the threads could have been set on a rotating convex form, i.e. from the outside, beginning from the prepared rim band. The rotation could have been provided by a potter’s wheel (*Stern – Schlick-Nolte 1994*, 71–72). Another possibility is that twisted threads were first wound on a flat base and then set on a mould. Opinions differ on the way the twisted threads were heated during their application to the mould and on how the mould itself was heated (*Nenna 1999*, 36, with refs.).

Typology and chronology. Deeper vessels – bowls with rounded walls, a convex base and spirally wound and horizontally set twisted threads belong to early – Hellenistic – reticella type vessels. This early type belongs to the Canosa group and is dated to the period between the end of the 3rd century BC and the end of the 2nd century BC (*Oliver 1968*; see below for details on this group). Later vessels from the Augustan period differ from them by the presence of a ring-shaped foot and the parallel placement of the twisted threads on the vessel, from one rim of the vessel, over the bottom, to the opposite rim (*Grose 1984*, 30, Fig. 5). In general, the combination of threads of more than two colours on a single vessel is also a later feature (*Harden 1968*, 43). The elementary combination of colourless and white or yellow glass, as is seen on Moravian bowls, as well as a white and blue rim are typical traits of these earlier vessels (*Goldstein 1979*, 32, with refs.; *Nenna 1999*, 36–37, with refs.). Spirally wound reticella was spread from Nimrud in Mesopotamia to Canosa in Italy (*Stern – Schlick-Nolte 1994*, 111), which can also be said of reticella vessels in general (*Nenna 1999*, 43, 45; *Stern – Schlick-Nolte 1994*, 272).

Ribbon glass vessels

Ribbon glass, or onyx-mosaic glass (*Bandglas*, *Achatglas*), is regarded as an imitation of semi-precious stone (onyx). The lone piece from Staré Hradisko (vessel no. 13) has violet-white bands in a honey brown field – a typical colour scheme for ribbon glass vessels. Middle and Late Hellenistic ribbon glass vessels from the 2nd century BC to the early 1st century BC are commonly made from brown or violet glass with white spirals or meander decoration (*Tatton-Brown – Andrews 1991*, 50). *M.-D. Nenna* (*1999*, 35) dates the beginning of the manufacture of ribbon glass to the end of the 2nd century BC. The wavy bands could in reality belong to the sections of enlarged spirally wound canes (*Tatton-Brown – Andrews 1991*, 50–51, Fig. 58); however, other alternatives for their manufacture have also been suggested. Threads of multiple colours could have been set on a convex mould or disc from one rim to the other, and when heated their lines would have been deformed to create linear motifs with various serpentine effects. Lengthwise sections of multicoloured canes could also have been used, or threads or canes could have been set on a layer of monochrome glass (*Nenna 1999*, 41–42). The relevant technique cannot be determined from the small vessel (no. 13) fragment from Staré Hradisko. Four fragments of ribbon glass were found at Manching during the excavations conducted in 1955–1972 (*Gebhard – Feugère 1995*, 505–506, Abb. 1: 7–10). Another variation of ribbon glass includes gold bands (*gold-band Glas*, *verre à ruban d'or*) and was made perhaps as early as the first half of the 1st century BC (*Berger – Jouve 1980*; *Oliver 1967*, 33); it was not part of the Delos collection (*Nenna 1999*, 42). The origin of ribbon glass is traced to the eastern Mediterranean.

The European context of Hellenistic mosaic vessels

Chronology

In which time horizon were the mosaic vessels from Bohemian and Moravian La Tène finds made? Based on the dating of the collections from Stradonice, Staré Hradisko and

Jičina-Požaha, the vessels come from the LT C2-D find context, i.e. from between the 2nd century BC to the second half of the 1st century BC. Assuming a certain delay from the date of manufacture, the local vessels could exhibit characteristics of both groups – Canosa and Antikythera-Delos. If this conclusion can be reached from small fragments, the vessels can be reconstructed as deeper hemispherical bowls with slightly inverted rims (Staré Hradisko – 11, Jičina-Požaha – 17), bowls with everted rim (Staré Hradisko – 3, 4, 10) and generally as bowls with straight or rounded walls (the other small fragments that cannot be classified in greater detail). The diameter of the measurable bowl mouths is 10 to 12.5 cm.

These characteristics probably classify the vessels as type 1 Hellenistic glass polychrome vessels according to M.-D. Nenna (hemispherical deep bowls with a convex base, mouth diameter of 12–14 cm, height of 8–9 cm: vessel no. 11) or her type 2 (hemispherical shallow bowls with a convex base, mouth diameter of 10–13 cm, average height of 6 cm). Type 1 is dated to the period between the end of the 3rd century BC to the beginning of the 1st century BC, type 2 to the period between the second half of the 2nd century BC and the beginning of the 1st century BC (*Nenna 1999*, 43–45). The absence of rims of a different colour could be diagnostic: although two of the five rims of mosaic vessels in the studied assemblage are not of a different colour, the small number of available rim fragments cannot be used to reach general conclusions. If the vessels had a ring-shaped foot, they would belong to the first century BC, but due to the absence of vessel bottoms in the assemblage, this can neither be proven nor refuted, and hence this alternative remains unresolved. However, the characteristics of the earlier period seem more prevalent and are explicitly applicable to the reticella vessels in the studied assemblage (see above). As established above, onyx-glass vessels are dated to the 2nd or early 1st century BC. The period between the end of the 2nd century BC and the beginning of the 1st century BC was marked by general growth in finds of mosaic vessels, a much higher production of which is assumed (*Nenna 1999*, 180). Mosaic vessels found in Bohemia and Moravia are therefore probably the products of the 2nd century to the beginning of the 1st century BC, though it is impossible to establish which half of the second century this involved. This corresponds to the LT C2-D1 period in La Tène Europe.

The high point in the manufacture and use of mosaic vessels, especially bowls, came later in the Augustan period and following years of the first century AD, which is already beyond the scope of this work.

Distribution and origin

It is well known that Hellenistic mosaic vessels, especially bowls, are widespread throughout the entire Mediterranean in all places with a demand for luxury glass (*Tatton-Brown – Andrews 1991*, 50). However, they are quite rare in the Syro-Palestinian region, where a different type is known with certainty to have been manufactured – monochrome cast vessels, as is indicated by an assemblage from Tel Anafa, Israel (*Davidson Weinberg 1970*; *Grose 1981*). It is thought that mosaic vessels may have been imported to Tel Anafa from Alexandria or the Aegean (*Jackson-Tal 2004*, 25, 27, Tab. 3). According to *M.-D. Nenna* (*1999*, 166, 172–176; *2002*, 154), Alexandria, Memphis and other cities (perhaps each city had its own glassworks) are definitely locations where the manufacture of Hellenistic mosaic vessels began, considering both the glassmaking tradition in general and the tradition of millefiori inlays in Egypt. Production in Italy is thought to have only begun with Augustan mosaic glass.

The publication of the enormous assemblage of Hellenistic mosaic vessels from the island of Delos (*Nenna 1999*) was an impetus for a new direction of thought on their provenance. While only several dozen polychrome vessels of the Canosa group, i.e. from the end of the 3rd century and the 2nd century BC, are known, there are many more vessels of the later Antikythera-Delos group dating from the end of the 2nd century to the beginning of the 1st century BC. Delos alone has produced nearly one hundred pieces, and others were known to *M.-D. Nenna* (*1999*, 180, Pl. 40) from around thirty more sites in the classical world. Nevertheless, this author does not believe that vessels were manufactured on Delos because production relics are only related to small ornaments (*Nenna 1999*, 166). The location there of a possible secondary workshop for mosaic glass remains debatable.

The opinion on the existence of primary, i.e. glassmaking, workshops on the Syro-Palestinian coast (*Nenna – Gratuze 2009*, 203) is supported by finds of large tank glass furnaces that were probably in operation in Beirut before 50 BC at the latest, or in the Late Hellenistic period (second century to the beginning of the first century BC), a time marked by the mass production of glass, unlike the preceding Middle Hellenistic period, when smaller furnaces and workshops can probably be expected. It is also possible that other primary workshops existed in the Late Hellenistic period in Syria and in northern Africa or even on Rhodes (*Henderson 2013*, 209–223). Hence, it is impossible to determine today from which part of the Mediterranean mosaic vessels were imported into barbarian (La Tène) Europe.

Finds of Hellenistic mosaic vessels in La Tène (pre-Roman) Europe

This list provides only finds with a relatively reliable La Tène (pre-Roman) find context (*fig. 4*). Based on published finds, the number of sites with finds known today is around twice the number compared to the list from 1980 (*Berger – Jouve 1980*, 13); however, this number is most certainly very incomplete. The aim of the current list is merely to point out this type of glass import to La Tène Europe.

1. **Basel – Gasfabrik** (Kanton Basel-Stadt, Switzerland). Open settlement. A fragment of a reticella vessel. LT D. *Furger-Gunti – Berger 1980*, 97, nr. 442, Tab. 19.
2. **Bordeaux** (dép. Gironde, France). Settlement. A fragment of a reticella vessel, possibly from a context dating to 80–50 BC. *Hochuli-Gysel 2003*, 178, fig. 2: 4.
3. **Jičina-Požaha** (Nový Jičín district, Czech Republic). Hilltop settlement. One fragment of a reticella vessel (see above).
4. **Lacoste** (comm. Mouliets-et-Villemartin, dép. Gironde, France). Settlement. A fragment of a reticella vessel, possibly from a context dating to the second century BC. *Hochuli-Gysel 2003*, 178.
5. **Manching** (Ldkr. Pfaffenhofen, Germany). Lowland settlement / oppidum. At least three millefiori and four onyx-glass vessels. LT C2-D. *Gebhard – Feugère 1995*; *Sievers 1998*, 644, Abb. 9: 2; *2013*, 196, Abb. 62: 2.
6. **Mont Beuvray – Bibracte** (dép. Saône-et-Loire, France). Oppidum. The excavation from 1984–2001 alone produced around fifteen millefiori vessel fragments and one reticella vessel fragment; as all finds date to the period between the first century BC and the first century AD, both Hellenistic and later vessels can be represented (*Berger – Jouve 1980*, 13; *Bride 2005*, 123–154).
7. **Staré Hradisko** (Prostějov district, Czech Republic). Oppidum. Thirteen fragments: eleven fragments of millefiori vessels, one reticella and one onyx-glass fragment (see above).

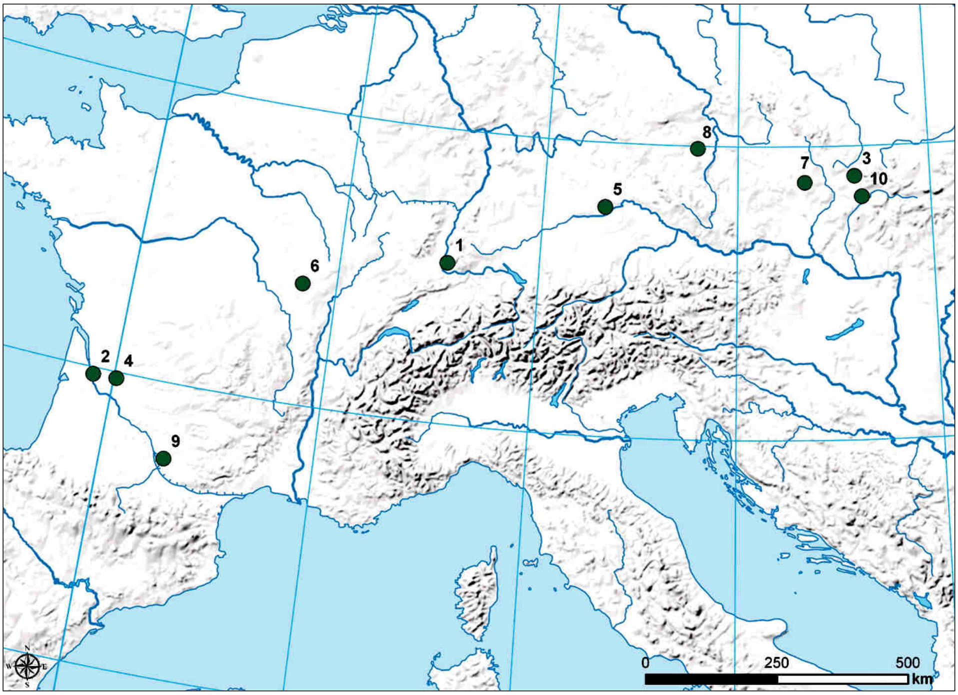

Fig. 4. Hellenistic mosaic glass vessels in La Tène (pre-Roman) Europe. Numbers correspond to site numbers in the list on pp. 224–225.
Obr. 4. Helenistické mosaikové skleněné nádoby v laténské (předřímské) Evropě. Čísla odpovídají číslům lokalit v soupisu na str. 224–225.

8. **Stradonice** (Beroun district, Czech Republic). Oppidum. Three fragments of millefiori vessels (see above).
9. **Toulouse** (dép. Haute-Garonne, France). Open settlement. At least four millefiori vessels, LT C2-D. Information provided by J. Rolland.
10. **Trenčianské Teplice** (Trenčín district, Slovakia). Ritual site. A fragment of a millefiori vessel. Late LT D1. *Pieta 2000*, 143, Abb. 9: 14. (The combination of green and yellow does not rule out the possibility that it was a product of the Late Roman period; cf. *Nenna 2002*, 156–157, Note 25.)

A millefiori fragment from around Komárno, Slovakia, has not been included on the list of finds from La Tène Europe, as it is highly probable that the fragment belongs to the assemblage from the Roman camp – castellum in Iža (Slovak National Museum in Bratislava inv. no. 13736, R 169; the authors thank G. Březinová and R. Čambal for the information). The millefiori ornament in this case differs from standard Hellenistic types.

The small number of finds in La Tène Europe was used to infer the lack of local interest in luxury mosaic glass drinking vessels (*Gebhard – Feugère 1995*, 511). While mosaic glass was certainly an exceptional article, the find situation is doubtlessly distorted by the great fragmentation and poor preservation of fragile vessels whose small, often corroded, glass sherds could escape attention when less sophisticated excavation methods are used; it is also possible that other finds have not been properly classified. Nevertheless, the relatively large number of thirteen mosaic vessels from Staré Hradisko in Moravia is remarkable and is apparently the result of the fact that this oppidum was situated along the heavily travelled Amber Route running from the Adriatic to the north and back. In comparison, Manching produced only half the number of mosaic vessels. A larger number of vessels is known only from Mont Beuvray, where, however, it is not certain what percentage of the collection of mosaic vessels is already Augustan.

Transport to barbarian Europe clearly did not represent a problem – overland routes have been mapped sufficiently well. Ship cargo documents the sea transport of Hellenistic glass vessels of the pre-Augustan period, including mosaic vessels. This primarily concerns a shipwreck from 70–60 BC near the island of Antikythera (*Davidson Weinberg 1965*; *Nenna 1999*, 50, with refs.), eponymous for a group of Hellenistic vessels (the Delos-Antikythera group); the ship was carrying just under twenty glass vessels, ten of which were mosaic vessels. The Camarat 2 shipwreck, which sank off the southern coast of France around the middle of the 1st century BC, was carrying six glass vessels, one of which was a millefiori vessel. This is explained as the personal property of one of the crew members, not as an article of trade (*Foy – Nenna 2003*, 229–231, Fig. 7: 1).

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Chemical composition of Mediterranean mosaic glass vessels

There are considerably fewer comparative results from the chemical analysis of Mediterranean mosaic glass than from the analysis of La Tène glass products.

LA-ICP-MS analyses of the chemical composition of mosaic glass from the Hellenistic and Augustan periods up to the Late Roman period were conducted and published in preliminary form by *Nenna* and *Gratuze* (*2009*). An assemblage from Tebtynis, Egypt, and the island of Delos date to the pre-Augustan period. A large part of the analysed glass was characterised as natron glass, while most of the orange and red glass, sometimes even the colourless and blue glass, was produced from ash glass. With a single exception, the glass from Delos was natron glass.

Gedzevičiute et al. (*2009*) used EPMA and Raman microspectroscopy to analyse two fragments of Hellenistic millefiori vessels and also later mosaic glasses. No differences were determined between Hellenistic, Ptolemaic and Early Imperial products, all of which were made from natron glass. The composition of two Hellenistic vessels (*Gedzevičiute et al. 2009*, Tab. 1, samples 2 and 6) corresponds to the mosaic glass from Staré Hradisko and Stradonice analysed in this contribution. *Stapleton* (*2003*) also observed the unchanged glass composition of mosaic vessels over a longer period of time.

Henderson (*2013*, 235–251) addressed the chemical composition and origin of Late Hellenistic glass, especially from the Levant (in particular after 50 BC), in comparison with Roman glass. He created graphs comparing specific elements based on analyses published by *Thirion-Merle* (*2005*), which demonstrate, among other things, the considerable similarity of the composition of natron glass manufactured in the Syro-Palestinian region between the first century BC and the first century AD, or in general, from the Hellenistic period through several subsequent centuries.

The chemical composition of mosaic vessels from Bohemia and Moravia

All available and adequately preserved fragments of mosaic vessels from Bohemia and Moravia were subjected to chemical analysis with the aim of comparing this glass both with Hellenistic mosaic glass from the Mediterranean finds and with La Tène glass, i.e. personal glass ornaments made in La Tène Europe, although probably from imported raw glass presumably made in the Mediterranean. Not many glass analyses are available from the Mediterranean for comparison (see above); contrary to that, there are series of analysed La Tène glasses published from different sites in Bohemia and Moravia (e.g. *Frána – Maštalka 1994*; *Venclová et al. 2009*; see below), as well as a large sample series from Manching in Bavaria (*Gebhard 1989*) and eastern Austria (*Karwowski 2004*), among others. The precision of chemical data, though, depends on the date and type of performed analyses.

Samples

The SEM-EDS analysis (V. Hulínský, Š. Jonášová) involved eleven mosaic vessels from Staré Hradisko (the numbers correspond to the inventory, see above): no. 2, 3, 4, 5, 6, 7, 9, 10, 11, 12, 13, and two vessels from Stradonice: no. 14, 15. A total of thirty-six samples were analysed. When possible, glass of different colours was analysed from each vessel. The analysed glass colours are listed in the tables. Sample numbers correspond to those in the VITREA database (http://www.arup.cas.cz/VITREA/Index.htm).

For comparison, five additional glass objects were also analysed by SEM-EDS – bracelets and ring beads (six samples) from Staré Hradisko belonging to La Tène products from the LT C2-D1 period (*fig. 5*). (Typological groups after *Haevernick 1960*; *Venclová 1990*; the numbering of analysed objects follows up with the numbers of the List of Hellenistic mosaic glass vessels in Bohemia and Moravia, see above.)

18. Blue bracelet, Group 12b, Prostějov Museum inv. no. M265/23-38642, sample 630.
19. Light green bracelet with yellow foil, Group 8f, Boskovice Museum inv. no. 602-1875, matrix glass analysed, sample 648.
20. Colourless bracelet with yellow foil, Group 16, Boskovice Museum inv. no. 602-1876, matrix glass analysed, sample 649.
21. Ring bead, violet with yellow whirl decoration, Group 23, Prostějov Museum inv. no. M245/1566-1-36528, matrix glass analysed, sample 631.
22. Ring bead, honey brown with yellow whirl decoration, Group 23, Moravian Museum in Brno inv. no. 57805, matrix and decoration glass analysed, samples 632, 700.

To determine the content of trace elements, selected samples of glass from Staré Hradisko were also subjected to neutron activation analysis (J. Frána, M. Fikrle), and glass from Stradonice to LA-ICP-MS analysis (T. Vaculovič).

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SEM-EDS analysis

SEM-EDS analysis (Scanning Electron Microscopy with Energy Dispersive Spectrometry) has already been applied several times to archaeological glass in the Czech Republic. In addition to early and high medieval glass, Bronze Age, Iron Age and Migration Period glass has also been analysed using this method (*Venclová et al. 2011*; *2009*; *Venclová – Hulínský – Jonášová 2014*).

The SEM-EDS analysis of Iron Age glass samples from Staré Hradisko presented in this work was conducted in the Laboratory of the Department of Glass and Ceramics of the Institute of Chemical Technology in Prague (V. Hulínský), and analysis of samples from Stradonice in the Department of Analytical Methods of the Institute of Geology, The Czech Academy of Sciences (Š. Jonášová).

Method. The Hitachi S4700 scanning emission microscope equipped with a Thermo Scientific UltraDry EDS Detector, model 4457G-IUES-SU, was used at the Institute of Chemical Technology. Operating conditions: accelerating voltage 15 kV, beam current of primary electrons 8×10^{-10} A. The quantification of the measured spectra obtained by scanning an area typically of 10x10 microns (depending on the magnification used) was performed using a ZAF iterative program using the Corning Glass B reference glass standard provided by R. Brill (Corning Museum of Glass).

A Tescan Vega 3XM scanning emission microscope equipped with a micro-analytical system with a Bruker EDS Detector and a Quantax 200 multipurpose system of energy-dispersive analysis was used at the Institute of Geology. Operating conditions: accelerating voltage 20 kV, working distance for analysis of 15 mm. The quantification of the measured spectra obtained by scanning an area typically of 10x10 microns (depending on the magnification used) was performed using a ZAF iterative program.

The analyses were conducted on polished areas of c. 0.5–1 mm^2 on the glass objects (see *Černá – Hulínský – Gedeon 2001* for a description of the method) so as to remove the corrosion layer from the surface and to precisely define the geometric conditions of the micro-analysis, including the take-off angle of the spectrometer and the correct angle with the electron beam. The analytical spectra were measured at a minimum of three areas and collected for 120 seconds. The analyses are quantitative, with c. 5% relative accuracy for each element.

Elements not measured: Ti, Co and Sb in the samples from Staré Hradisko; Ti, Co in the samples from Stradonice.

Results. The results are presented in *Tab. 1*. The glass from the mosaic vessels and La Tène ornaments belongs to the chemical type of soda-lime natron glass. As expected, the glass of La Tène bracelets and ring beads from Staré Hradisko (samples 630, 631, 632, 648, 649) is highly similar to La Tène glass from Němčice, cluster 3 (*Venclová et al. 2009*, Tab. 3). The mosaic glass essentially does not differ from La Tène bracelets and beads, and is similar to clusters 2 and 3 from Němčice (*Venclová et al. 2009*, Tab. 3). Vessel no. 7, permitting, on typological grounds, some doubts on its date and origin, did not show any significant differences compared to other analysed vessels.

A high content of Fe_2O_3 is typical for blue glass, and Co and Cu also contribute despite their small amounts (according to other employed analytical methods, see below). The main colorant in green glass (samples 704, 1072) was apparently CuO. Violet glass has a high MnO content of over 2–3%.

Opaque yellow millefiori glasses from Staré Hradisko (samples 642, 703, 707, 1071, 1138) and the opaque yellow decoration of a La Tène ring bead (sample 700) have a high Pb content. Although antimony was not measured by SEM in the samples of mosaic glass from Staré Hradisko, according to the samples analysed using NAA and LA-ICP, yellow glass undoubtedly contains it. Antimony was also determined in the yellow mosaic glass from Stradonice (samples 1071, 1138), which were apparently coloured by lead antimonate. The yellow decorative glass of the ring bead (sample 700) differs – it has a high Sn content and was hence probably coloured by $PbSnO_3$. Yellow glasses with a high Pb content naturally have a lower content of SiO_2, and also Na_2O. They can possibly have a higher Fe_2O_3 content. White glass also contains similar colorants; if it does not contain lead, then it could have been coloured by calcium antimonate (sample 1139).

VH, ŠJ

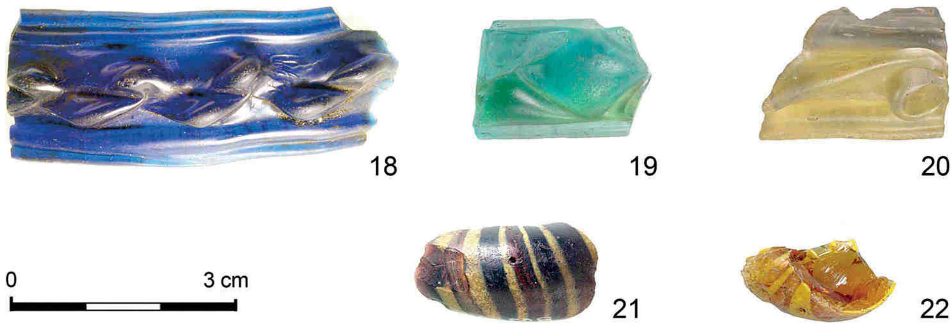

Fig. 5. Analysed La Tène glass bracelets and ring beads from Staré Hradisko, Moravia. Numbers correspond to the list on p. 227. Photo H. Toušková.
Obr. 5. Analyzované laténské skleněné náramky a prstencové korály ze Starého Hradiska na Moravě. Čísla odpovídají soupisu na str. 227.

NAA analysis

NAA (Neutron Activation Analysis) has been employed in Czech glass research at the Nuclear Physics Institute of The Czech Academy of Sciences in Řež near Prague since the 1980s (*Frána – Maštalka 1984*; *1990*; *1994*; *Frána – Maštalka – Venclová 1987*; *Frána 2005*; *Venclová et al. 2009*; *Březinová et al. 2013*). In the context of the research presented here, only a small series of eleven samples of six mosaic glass vessels from Staré Hradisko was measured.

The role of NAA in the analysis of the elemental composition of glass is complementary to other analytical methods. However, the possibility to determine very low concentrations of trace elements is most useful for establishing the origin of glass or its colouring techniques. It should be noted, though, that there is a group of chemical elements which are difficult or impossible to detect by NAA – Si, B, Pb, P, S and Bi. XRF measurement was performed in selected cases to establish the Pb content.

Method. Small fragments of the artefacts under study were submitted for NAA. In the case of millefiori glass, where it was necessary to analyse glass of different colours of the sample, attention had to be paid to precise sample preparation. To avoid contamination, the samples were packed in polyethylene film before being gently crushed in a vice. The aim was to have the largest possible fragments of a single colour of millefiori glass. Crushed fragments of the same colour were manually separated under a strong magnifying glass and weighted for irradiation. The samples were irradiated in the LVR15 reactor at the Řež Research Centre (a member of the Nuclear Physics Institute Group). Both short-term (1 minute) and long-term (2 hours) irradiation were performed. If the amount of the sample was not sufficient for separate long and short-term activation, the short-term activation was carried out first and after the decay of short-lived isotopes the long-term activation of the same sample was conducted.

Results. The elemental composition of the glass is summarised in *Tab. 2*. Only trace elements and colorants are given, as the major elements were measured by another method (SEM-EDS, *tab. 1*).

The analysed glass from both the mosaic vessels and the La Tène bracelets and ring beads (analysed earlier by NAA) belongs to the soda-lime (natron) glass. According to trace elements and colorants, it is possible to include the whole set of samples in earlier defined groups C and F within the analysed La Tène glass collection from Němčice in Moravia (Frána and Fikrle in: *Venclová et al. 2009*). The content of Pb typical for group C was measured by XRF in three samples of mosaic glass: sample 629 – tenths of a percent; 647 and 642 – up to several percent of lead.

Vessel/ object no.	Sample description/colour	Sample no.	Na_2O	MgO	Al_2O_3	SiO_2	P_2O_5	SO_3	Cl	K_2O	CaO	MnO	Fe_2O_3	CuO	SnO_2	Sb_2O_3	PbO
	STARÉ HRADISKO																
2	blue	**629**	15.93	0.49	2.72	68.11	0.12	0.55	0.90	1.04	8.03	1.20	0.92	n/d	n/d	n/m	n/d
3	blue	**646**	15.48	0.59	2.83	69.58	n/d	n/d	0.81	1.01	7.32	0.66	0.96	0.53	n/d	n/m	nd
3	yellow	**703**	9.99	0.66	3.54	50.80	n/d	n/d	0.51	0.77	6.20	0.67	1.81	0.82	n/d	n/m	24.22
3	green	**704**	14.32	0.73	2.59	66.93	n/d	n/d	0.83	0.96	7.94	0.77	0.49	2.44	n/d	n/m	1.99
4	violet	**705**	16.23	0.81	2.71	65.49	0.25	n/d	0.92	1.08	7.86	2.48	0.99	n/d	n/d	n/m	1.18
4	white	**891**	14.85	0.74	2.99	61.46	n/d	n/d	0.72	1.14	7.88	0.94	0.46	n/d	n/d	n/m	8.83
4	turquoise	**892**	15.73	0.68	2.89	68.10	0.24	n/d	1.00	0.97	8.17	0.72	0.75	n/d	n/d	n/m	0.76
5	violet	**647**	17.78	0.78	2.79	64.94	0.21	0.99	0.96	0.86	7.75	2.94	n/d	n/d	n/d	n/m	n/d
5	honey brown	**702**	16.64	0.58	2.87	69.86	n/d	n/d	1.08	0.95	8.02	n/d	n/d	n/d	n/d	n/m	n/d
6	yellow	**706**	16.88	0.51	2.76	69.43	n/d	n/d	1.01	0.79	6.48	0.91	0.89	n/d	n/d	n/m	0.33
6	blue	**894**	14.66	0.56	2.35	63.03	0.29	n/d	0.68	0.80	7.43	1.27	0.86	n/d	n/d	n/m	8.07
6	blue-green	**893**	16.24	0.58	2.81	69.64	n/d	0.35	1.07	0.78	6.59	0.83	0.85	n/d	n/d	n/m	n/d
7	yellow	**707**	12.20	0.63	2.53	54.12	n/d	n/d	0.70	0.62	6.31	0.17	2.92	n/d	n/d	n/m	19.84
7	white	**895**	17.39	0.77	2.43	65.54	n/d	0.3	0.43	0.61	8.33	0.79	1.09	n/d	n/d	n/m	n/d
7	light blue	**896**	16.77	0.77	2.68	66.55	n/d	0.58	0.84	0.7	8.13	1.33	1.64	n/d	n/d	n/m	n/d
7	dark blue	**897**	17.24	0.75	2.51	65.76	n/d	0.45	0.56	0.76	8.28	0.99	2.7	n/d	n/d	n/m	n/d
9	white	**708**	13.76	0.73	4.10	67.54	n/d	n/d	0.78	0.91	8.50	0.86	2.02	n/d	n/d	n/m	0.80
9	violet	**898**	14.12	0.83	2.54	67.96	n/d	n/d	0.70	0.95	8.33	2.31	0.96	n/d	n/d	n/m	1.29
10	white	**709**	13.41	0.52	2.66	66.65	n/d	n/d	0.63	1.10	9.28	n/d	n/d	n/d	n/d	n/m	3.84
10	blue	**785**	15.79	0.51	2.81	68.39	n/d	0.44	0.82	0.73	8.49	0.33	1.12	n/d	n/d	n/m	n/d
10	violet	**899**	15.85	0.84	2.75	66.20	0.31	n/d	0.90	0.98	7.91	2.71	0.89	n/d	n/d	n/m	0.88
11	colourless	**641**	17.12	0.66	2.95	69.67	n/d	0.45	0.72	0.83	6.09	0.97	0.52	n/d	n/d	n/m	n/d
11	yellow	**642**	12.65	0.77	2.76	50.81	n/d	n/d	0.69	0.63	4.50	0.49	0.86	n/d	n/d	n/m	25.84
11	blue	**643**	13.95	1.40	2.64	67.16	n/d	0.80	0.93	1.10	8.37	2.22	1.42	n/d	n/d	n/m	n/d
12	reticella - colourless	**644**	16.04	0.48	2.86	69.91	n/d	0.36	0.78	0.68	7.74	0.82	0.34	n/d	n/d	n/m	n/d
12	reticella - white	**701**	14.37	0.60	2.73	68.30	n/d	0.66	0.46	0.83	10.93	0.76	0.35	n/d	n/d	n/m	n/d
13	ribbon glass - honey brown	**639**	18.56	0.55	2.65	69.72	0.16	n/d	1.01	0.60	6.74	n/d	n/d	n/d	n/d	n/m	n/d
13	ribbon glass - violet	**640**	18.63	0.72	2.50	65.63	0.12	0.16	0.85	0.83	7.50	2.12	0.62	n/d	n/d	n/m	n/d
18	bracelet, blue	**630**	14.42	0.84	2.84	68.27	n/d	n/d	0.95	0.98	9.03	1.16	0.95	0.56	n/d	n/m	n/d
19	bracelet, light green	**648**	15.49	0.35	1.21	72.20	n/d	0.27	0.99	0.56	8.26	n/d	0.68	n/d	n/d	n/m	n/d
20	bracelet, colourless	**649**	17.86	0.65	2.72	68.26	n/d	0.19	1.01	0.71	7.22	0.61	0.78	n/d	n/d	n/m	n/d
21	ring bead, violet	**631**	17.31	1.01	2.61	66.08	n/d	0.33	0.96	0.90	7.27	2.95	0.27	0.32	n/d	n/m	n/d
22	ring bead, honey brown	**632**	16.78	0.58	2.54	72.58	n/d	n/d	0.93	0.73	5.47	n/d	0.40	n/d	n/d	n/m	n/d
22	same ring bead - yellow decor.	**700**	8.50	0.76	2.85	45.80	n/d	n/d	0.76	0.81	5.11	0.98	n/d	n/d	4.68	n/m	29.74
	STRADONICE																
14	yellow	**1071**	9.55	0.73	2.83	46.74	n/d	n/d	0.37	0.40	4.95	0.67	1.74	n/d	n/d	1.61	30.41
14	blue	**1134**	17.49	0.84	3.15	63.32	n/d	n/d	0.82	1.03	10.27	0.58	1.69	n/d	n/d	n/d	0.81
14	colourless, greenish tint	**1135**	17.96	0.83	3.02	64.80	n/d	0.41	0.98	0.90	10.00	0.63	0.48	n/d	n/d	n/d	n/d
14	white	**1136**	9.51	0.69	2.63	55.60	n/d	n/d	0.60	0.50	5.99	0.52	0.52	n/d	n/d	2.73	20.71
15	green	**1072**	17.84	0.82	2.72	62.66	n/d	0.22	0.63	1.08	9.16	0.33	0.70	2.26	n/d	n/d	1.59
15	violet	**1137**	18.41	0.84	2.51	63.64	n/d	0.27	0.65	1.13	7.48	3.86	0.53	n/d	n/d	n/d	0.68
15	yellow	**1138**	9.40	0.94	4.03	46.75	n/d	n/d	0.43	0.66	5.62	0.65	2.41	0.63	n/d	2.02	26.34
15	white	**1139**	16.18	0.82	2.85	61.86	n/d	0.94	0.47	1.11	9.06	1.14	0.90	n/d	n/d	4.68	n/d

Tab. 1. SEM-EDS analysis of mosaic glass vessels (no. 2 to 15) and La Tène glass bracelets and ring beads (objects no. 18 to 22) from Staré Hradisko and Stradonice. Contents in wt%. n/d: not detected, n/m: not measured.
Tab. 1. Analýza SEM-EDS. Mosaikové skleněné nádoby (č. 2 až 15) a laténské náramky a prstencové korále (č. 18–22) ze Staréhо Hradiska a Stradonic. Obsah v %hm. n/d: nedetekováno, n/m: neměřeno.

Another aim of the work was to analyse glasses of different colours in mosaic vessels. This produced the expected results. Blue glass was coloured by a mixture of Co and Cu, aided by a relatively high content of iron. Violet glasses differ in Co content, which is approximately one order of magnitude lower than in blue glass. Typical is the Mn_2O_3 content of 1.3 to 2.5 %, compared to around 2.5 % in the La Tène glass from Němčice and The Netherlands (cf. *Venclová et al. 2009*, Tab. 13). The concentration of Sb in violet glass is less than half compared to blue glass.

Other analysed glass colours were honey brown, white and yellow. One honey brown glass (sample 702), white glass (sample 644) and yellow glass (sample 642) had a slightly above-average Sb content. The highest content of Sb, though, was surprisingly found in the blue glass of sample 643; however, as samples 642 and 643 come from the same vessel, the explanation is probably a contamination of blue glass by yellow glass, in which a high content of Sb is the norm (see the SEM-measured samples 1071, 1136 and 1138 in *Tab. 1*).

The composition of green glass (sample 704) is slightly different from La Tène glass containing c. 2.5 % of Al_2O_3 (measured by NAA and SEM-EDS) compared, e.g., to 4.5 to 6 % in the green La Tène glass from Němčice (*Venclová et al. 2009*, Tab. 11).

There was one sample (641) of colourless glass. Only two colourless glass samples from the Němčice collection (*Venclová et al. 2009*, Tab. 10) were measured by NAA. A comparison of these results shows that there was a high content of Mn (up to one percent of Mn_2O_3 in sample 641 and c. 0.3% in Němčice) and Sb (c. 0.3% in sample 641 and 0.4 to 0.8% in Němčice).

Vanadium can be an important element in glass samples. This element could be a marker of violet glass, because the concentrations of vanadium in this glass are slightly higher (c. one-third) than in glass of other colours. This theory will need to be proved on a statistically significant number of samples.

It can be summarised that the analysed mosaic glass compared, for example, to the La Tène glass collection from Němčice in Moravia, shows only statistically insignificant differences. Individual colours of mosaic glass were achieved by colorants similar to those used in La Tène glass.

JF, MF

LA-ICP-MS analysis

The use of the Laser Ablation Inductively Coupled Plasma Mass Spectrometry (LA-ICP-MS) in the Czech research of archaeological glass began only recently as part of an ongoing Czech Science Foundation project. This type of analysis offers the advantage of the precise measurement of a broad spectrum of elements. The analyses were conducted in the laboratory of the Institute of Chemistry, Faculty of Science at Masaryk University in Brno (T. Vaculovič). LA-ICP-MS analysis could be employed only at the conclusion of the mosaic glass research and was only used on vessels no. 14 and 15 from Stradonice (two vessels, seven samples).

Method. The minor and trace analysis of glass samples was performed with LA-ICP-MS equipment consisting of a laser ablation system UP213 (NewWave) and ICP-MS spectrometer Agilent 7500ce (Agilent), which is equipped with a collision-reaction cell for suppressing possible isobaric interferences. Under optimised laser ablation parameters (laser spot size of 65 μm, repetition rate of 10 Hz, laser beam fluence of 15 $J.cm^{-2}$) each sample was analysed on five different places due to possible heterogeneities. The glass certified reference material NIST610 was used for quantification purposes. All elemental contents were normalised using the total sum of oxide content normalisation (*Halicz 2004*).

Results. The content of minor and trace elements is summarized in *tab. 3*, where the whole range of measured elements is given. All values are expressed in mg/kg, and the uncertainty is approximated to two significant digits. As follows from *tab. 3*, the samples mainly differ in their content of Mn, Fe, Co, Cu, Sb and Pb.

Four differently coloured zones (glasses) were analysed in vessel 14 (samples 1134, 1135, 1136 and 1071). Yellow glass 1071 and white glass 1136 differ by the very high content of Sb and Pb (Sb: 20 340 and 22 500 mg/kg, Pb: 315 000 and 173 000 mg/kg) from the other two samples 1134 – blue and 1135 – green (Sb: 1050 and 5600 mg/kg, Pb: 5700 and 47 000 mg/kg). However, yellow glass 1071 and white glass 1136 differ from each other as well. The first one contains a higher amount of Pb and Fe (315 000 vs. 173 000 mg/kg and 8200 vs. 2301 mg/kg, respectively). Moreover, they differ in trace elements as well. The content of Ag and Sn is markedly higher in yellow sample 1071 compared to white sample 1136. In contrast to vessel 15, the content of Mn is nearly constant in all four glass colours (from 2471 to 3210 mg/kg).

Vessel no.	Sample colour	Sample no.	Cl	Sc	Ti	V	Cr	Mn	Co	Cu	Zn
2	blue	629	10778.00	0.73	n/d	10.45	7.50	5610.50	854.40	646.00	n/d
3	blue	646	10199.65	0.87	n/d	9.99	n/d	4511.20	1232.05	26400.00	n/d
3	green	704	9398.65	1.03	n/d	12.48	10.50	4643.85	83.30	42000.00	n/d
5	violet	647	11786.00	0.95	n/d	17.00	n/d	9463.40	36.10	29000.00	n/d
5	honey brown	702	12212.50	0.79	n/d	10.83	n/d	1381.20	6.10	n/d	n/d
11	colourless	641	8333.75	1.30	n/d	14.81	n/d	6970.40	7.74	n/d	n/d
11	yellow	642	8629.30	1.20	n/d	14.67	43.70	6529.35	20.50	26000.00	n/d
11	blue	643	9069.70	1.48	n/d	17.54	n/d	8414.65	498.90	32000.00	n/d
12	white	701	9623.25	0.77	n/d	13.04	n/d	5881.50	13.00	n/d	n/d
13	honey brown	639	11494.50	0.88	n/d	6.22	13.26	106.00	1.97	33000.00	12.77
13	violet	640	9145.60	1.10	n/d	25.60	15.70	17568.50	25.30	34000.00	53.31

Tab. 2. NAA analysis of mosaic glass vessels from Staré Hradisko. Contents in mg/kg. n/d: not detected.
Tab. 2. Analýza NAA. Mosaikové skleněné nádoby ze Starého Hradiska. Obsah v mg/kg. n/d: nedetekováno.

Vessel no.	Sample colour	Sample no.		Li	B	P	Sc	Ti	V	Cr	Mn	Fe	Co	Ni	Cu	Zn	As	Rb	Sr	Y
14	yellow	1071	w	**2.77**	**136**	**198**	**3.19**	**256**	**11.05**	**8.75**	**3210**	**8200**	**10.9**	**8.09**	**256**	**32.5**	**21.0**	**6.34**	**271**	**4.17**
			SD	*0.37*	*14*	*25*	*0.16*	*10*	*0.79*	*0.44*	*150*	*350*	*6.2*	*0.88*	*17*	*1.8*	*1.1*	*0.51*	*17*	*0.21*
14	blue	1134	w	**6.45**	**268.5**	**334.5**	**4.29**	**363**	**11.23**	**12.3**	**2940**	**7630**	**829**	**38.9**	**1005**	**99.6**	**12.0**	**7.9**	**417**	**6.51**
			SD	*0.40*	*8.7*	*6.5*	*0.29*	*22*	*0.74*	*1.2*	*180*	*470*	*67*	*3.7*	*65*	*5.9*	*1.3*	*1.1*	*29*	*0.66*
14	colourless, greenish tint	1135	w	**4.36**	**276**	**302.1**	**4.01**	**332**	**10.7**	**11.55**	**3220**	**3500**	**7.57**	**7.23**	**94.3**	**15.8**	**4.7**	**7.20**	**416**	**6.32**
			SD	*0.65*	*26*	*5.7*	*0.15*	*19*	*1.3*	*0.84*	*100*	*340*	*0.35*	*0.51*	*6.6*	*3.7*	*1.8*	*0.38*	*28*	*0.40*
14	white	1136	w	**2.26**	**185.9**	**247**	**3.27**	**312**	**9.62**	**9.97**	**2471**	**2301**	**4.51**	**6.88**	**237**	**33.9**	**26.2**	**7.01**	**342**	**5.74**
			SD	*0.32*	*8.5*	*19*	*0.32*	*26*	*0.58*	*0.47*	*93*	*64*	*0.59*	*0.35*	*30*	*3.5*	*3.7*	*0.31*	*17*	*0.13*
15	green	1072	w	**5.24**	**310**	**316.5**	**3.88**	**340**	**8.06**	**16.2**	**2270**	**3410**	**103.8**	**14.61**	**11730**	**23.7**	**78.3**	**8.06**	**389**	**4.98**
			SD	*0.20*	*11*	*7.9*	*0.10*	*22*	*0.39*	*1.4*	*120*	*230*	*5.2*	*0.80*	*930*	*1.7*	*6.5*	*0.18*	*10*	*0.12*
15	violet	1137	w	**4.49**	**253.7**	**257.0**	**3.99**	**340**	**25.8**	**14.7**	**21360**	**2762**	**33.3**	**24.3**	**1132**	**37.8**	**20.9**	**7.95**	**557**	**5.59**
			SD	*0.28*	*5.0*	*3.5*	*0.19*	*11*	*1.0*	*2.2*	*620*	*77*	*1.0*	*1.5*	*92*	*2.1*	*1.7*	*0.61*	*27*	*0.27*
15	white	1139	w	**4.75**	**274.1**	**376**	**3.83**	**455.9**	**12.00**	**9.22**	**5220**	**3760**	**10.15**	**8.32**	**70**	**25.8**	**11.67**	**8.06**	**419**	**6.81**
			SD	*0.45*	*7.4*	*78*	*0.19*	*8.8*	*0.53*	*0.84*	*300*	*340*	*0.61*	*0.79*	*20*	*4.7*	*0.67*	*0.19*	*30*	*0.52*

Tab. 3. LA-ICP-MS analysis of mosaic glass vessels from Stradonice. Contents in mg/kg. < under detection limit.
Tab. 3. Analýza LA-ICP-MS. Mosaikové skleněné nádoby ze Stradonic. Obsah v mg/kg. < pod detekčním limitem.

Three differently coloured zones (glasses) were analysed in vessel 15 (samples 1072, 1137 and 1139). The elemental composition of these three samples differs in the content of minor and trace elements. In the case of minor elements, the largest differences were observed for Mn, Cu, Sb and Pb. Green sample 1072 contains a markedly higher amount of Cu and Pb (11 730 mg/kg and 14 560 mg/kg), whereas the other glass of the object (violet sample 1137 and white sample 1139) contains 1132 and 70 mg/kg Cu and 6310 and 387 mg/kg Pb, respectively. Moreover, green sample 1072 contains a higher amount of trace elements such as As, Ag and also Sn (78.3, 11.16 and 103 mg/kg, respectively). The violet sample 1137 differs from the glass of other colours in its high content of Mn (21 360 mg/kg) which apparently produced the violet colouration. The white sample 1139 contains a high amount of Sb (31 800 mg/kg), which is c. four-times higher than in the other two samples. The rest of the determined elements do not show marked differences in their content between the three differently coloured glass samples of vessel 15 (e.g. Fe content ranges from 2762 to 3760 mg/kg).

TV

As	Sr	Sb	Ba	La	Ce	Nd	Sm	Eu	Yb	Hf	Au	Th	U
n/d	729.60	2703.30	351.00	6.79	8.40	n/d	1.18	0.30	n/d	0.75	n/d	0.55	36.39
n/d	n/d	3059.00	444.30	4.91	n/d	154.07	1.14	4.30	n/d	n/d	0.15	n/d	20.90
24.60	645.20	3864.10	298.10	6.35	12.40	n/d	1.19	0.30	n/d	1.81	0.36	0.83	n/d
n/d	n/d	1085.80	333.20	6.77	n/d	n/d	1.09	0.42	n/d	1.95	0.16	n/d	30.07
n/d	n/d	7790.50	n/d	n/d	n/d	n/d	1.04	0.30	n/d	2.17	n/d	0.66	n/d
n/d	n/d	3046.33	n/d	7.21	192.00	n/d	0.97	1.84	n/d	2.49	n/d	n/d	23.35
n/d	677.90	4512.25	468.50	5.40	n/d	n/d	0.85	0.45	n/d	n/d	0.12	n/d	42.51
n/d	n/d	11931.50	n/d	9.85	n/d	n/d	1.02	n/d	n/d	n/d	0.32	n/d	54.84
n/d	n/d	6022.40	n/d	n/d	10.60	n/d	0.85	n/d	n/d	n/d	n/d	n/d	18.56
n/d	456.20	2036.98	359.90	7.47	11.70	n/d	1.25	0.40	n/d	1.01	0.05	0.81	6.50
n/d	829.60	1965.70	364.20	9.44	12.60	n/d	1.60	0.40	n/d	1.15	n/d	0.84	0.68

Tab. 2. Continued – Pokračování.

Zr	Nb	Mo	Ag	Sn	Sb	Ba	La	Ce	Pr	Nd	Sm	Eu	Gd	Tb	Dy	Ho	Er	Tm	Yb	Lu	Hf	Pb	Th	U
25.1	**1.10**	**1.25**	**18.8**	**173**	**20340**	**166.5**	**6.37**	**10.03**	**1.21**	**5.22**	**0.99**	**0.317**	**1.03**	**0.163**	**0.96**	**0.231**	**0.51**	**<0.05**	**0.568**	**0.106**	**0.87**	**315000**	**1.54**	**0.95**
1.8	*0.10*	*0.30*	*2.6*	*16*	*490*	*4.1*	*0.19*	*0.65*	*0.11*	*0.42*	*0.23*	*0.09*	*0.14*	*0.05*	*0.19*	*0.03*	*0.12*	–	*0.06*	–	*0.12*	*20000*	*0.70*	*0.15*
41.2	**1.18**	**2.00**	**11.5**	**71.4**	**1050**	**222**	**6.29**	**10.41**	**1.42**	**6.01**	**1.41**	**0.49**	**1.44**	**0.208**	**1.11**	**0.307**	**0.81**	**0.148**	**0.59**	**0.178**	**1.05**	**5700**	**1.00**	**1.2**
3.0	*0.22*	*0.22*	*3.5*	*5.1*	*840*	*14*	*0.49*	*0.44*	*0.19*	*0.54*	*0.32*	*0.17*	*0.19*	*0.05*	*0.32*	*0.080*	*0.12*	*0.05*	*0.12*	*0.04*	*0.14*	*2700*	*0.17*	*0.18*
38.9	**1.10**	**1.52**	**3.10**	**34.6**	**5600**	**234**	**6.95**	**11.21**	**1.51**	**7.2**	**1.48**	**0.49**	**1.25**	**0.218**	**1.39**	**0.272**	**0.87**	**0.130**	**0.75**	**0.135**	**1.19**	**47000**	**1.13**	**1.43**
1.8	*0.13*	*0.23*	*0.22*	*5.1*	*1400*	*25*	*0.60*	*0.72*	*0.19*	*1.3*	*0.39*	*0.10*	*0.42*	*0.05*	*0.14*	*0.04*	*0.11*	*0.01*	*0.28*	*0.01*	*0.16*	*7600*	*0.24*	*0.16*
34.4	**1.18**	**1.42**	**2.52**	**25.5**	**22500**	**207.5**	**6.75**	**10.38**	**1.37**	**6.24**	**1.66**	**0.327**	**1.08**	**0.225**	**1.42**	**0.314**	**0.74**	**0.120**	**0.57**	**<**	**1.50**	**173000**	**1.21**	**1.18**
1.0	*0.11*	*0.10*	*0.28*	*1.4*	*3500*	*7.2*	*0.16*	*0.36*	*0.15*	*0.41*	*0.33*	*0.03*	*0.10*	*0.01*	*0.12*	*0.03*	*0.13*	*0.010*	*0.17*	–	*0.14*	*33000*	*0.10*	*0.17*
37.8	**1.23**	**1.00**	**11.16**	**103**	**8620**	**182**	**5.88**	**9.18**	**1.133**	**5.41**	**0.92**	**0.350**	**1.17**	**0.164**	**0.84**	**0.236**	**0.55**	**<0.05**	**0.511**	**0.124**	**0.95**	**14560**	**0.89**	**1.16**
1.4	*0.10*	*0.12*	*0.44*	*11*	*290*	*10*	*0.40*	*0.62*	*0.1*	*0.38*	*0.19*	*0.09*	*0.17*	*0.03*	*0.23*	*0.07*	*0.14*	–	*0.06*	–	*0.15*	*860*	*0.10*	*0.10*
36.1	**1.13**	**11.12**	**3.1**	**19.58**	**7350**	**270.2**	**6.14**	**9.22**	**1.286**	**5.30**	**1.13**	**0.270**	**1.00**	**0.173**	**0.98**	**0.299**	**0.57**	**0.158**	**0.60**	**0.121**	**1.06**	**6310**	**0.90**	**1.16**
1.6	*0.12*	*0.43*	*2.1*	*0.71*	*320*	*2.6*	*0.36*	*0.34*	*0.04*	*0.49*	*0.20*	*0.04*	*0.24*	*0.03*	*0.19*	*0.06*	*0.13*	–	*0.11*	–	*0.34*	*860*	*0.19*	*0.15*
45.9	**1.50**	**1.40**	**0.88**	**7.5**	**31800**	**212**	**7.23**	**11.77**	**1.564**	**6.69**	**1.47**	**0.35**	**1.53**	**0.210**	**1.13**	**0.217**	**0.66**	**0.105**	**0.707**	**0.131**	**1.28**	**387**	**1.40**	**1.35**
2.7	*0.13*	*0.31*	*0.41*	*1.0*	*2300*	*21*	*0.46*	*0.77*	*0.09*	*0.47*	*0.15*	*0.10*	*0.28*	*0.03*	*0.21*	*0.030*	*0.10*	–	*0.05*	–	*0.26*	*26*	*0.15*	*0.10*

Tab. 3. Continued – Pokračování.

Conclusion

The growth of elites in the Hellenistic world led to the increased demand for a wide range of luxury products, including glass tableware. Interest in such luxury goods was naturally not limited only to the Mediterranean but also appeared in pre-Roman Iron Age – Late La Tène Europe, as is documented by a large number of different imported artefacts at La Tène oppida and other settlement sites (cf. *Kysela 2014*). The occurrence of mosaic glass vessels is therefore not surprising in this context.

The mosaic glass of the studied vessels found in Bohemia and Moravia is characterised by similar chemical type of glass, i.e. soda-lime natron glass of the LMLK (low magnesia, low potash) type. It conforms with other Hellenistic glasses (e.g., from Gordion in Anatolia, and Greece incl. Rhodes: *Reade – Duncan Jones – Privat 2012*, 82–84, Fig. 1, 2, 4) not only in the MgO : K_2O content, but also in the CaO : Al_2O_3 ratio.

The relatively high content of strontium (271–419 ppm) and a low content of zirconium (25–46 ppm) according to LA-ICP-MS (NAA offered even higher Sr content) could correspond to the sand on the Levantine coast (*Freestone – Gorin-Rosen – Hughes 2000*, 73–74). The strontium content itself seems to indicate its (Near Eastern) coastal origin (*Freestone –*

Wolf – Thirlwall 2009, 35). The ratios of other trace elements (barium – according to LA-ICP-MS; higher values according to NAA) are also consistent with Levantine glass (*Henderson 2013*, Fig. 8.2, 8.3). A similar chemical type of glass, including the strontium and barium content, was also found in some La Tène glasses when sufficiently precise data is available (e.g., *Venclová et al. 2009*), perhaps indicating an origin of the raw glass of La Tène and mosaic objects in the same glassmaking area within the Hellenistic world.

Hellenistic vessels typically feature the same shades of highly coloured translucent glass known from La Tène glass, i.e. especially cobalt blue, violet and honey brown, and also colourless glass, while opaque glass is white or yellow. Whether the same colorants as those known from La Tène rings and beads were used is unclear. The use of antimony to create yellow opaque glass, as is the case in the studied mosaic vessels (and elsewhere: cf. *Gedzevičiute et al. 2009*, samples 2 and 6), conforms to the tradition of colouring opaque yellow glass in the Early Iron Age, for example, in the case of mask beads and stratified eye-beads from c. 6th and 5th centuries BC (cf. *Frána – Maštalka – Venclová 1987*, 75), a practice that lasted until the Roman period (e.g., *Tite – Pradell – Shortland 2008*; *Lahlil et al. 2010*). Colouring with Sn is a formula that was used from the second century BC for La Tène glass (e.g. *Frána – Maštalka 1994*, 590; *Venclová et al. 2009*, 416; *Henderson 2013*, 77–79, Fig. 3: 8 – sample of La Tène glass from Staré Hradisko), but also – concurrently with antimony – in the Roman Period (*Verità et al. 2013*); it was also highly used in the Migration Period (*Venclová – Hulínský – Jonášová 2014* with refs.). Nevertheless, Sn is not a colorant found in the mosaic glass components analysed in this study.

While La Tène ornaments were manufactured in pre-Roman Europe outside of the classical world from imported glass in numerous local secondary workshops from the middle of the 3rd century BC to around the middle of the 1st century BC, the same cannot be assumed for much more complex mosaic vessels, as the small number of local finds also suggests.

Noteworthy in this context is another exogenous glass that reached La Tène Europe – a relatively disparate group of monochrome cast vessels mostly preserved in small individual fragments that are typologically indistinctive and therefore may easily escape the attention of archaeologists. Their identification is practically impossible without determining their chemical composition. The study of these vessels is in its nascent stages, and they will be the focus of attention in a future work.

Chemical analyses of archaeological glass have become an indispensable part of the study of prehistoric and medieval glassmaking. The online VITREA database (http://www.arup.cas.cz/VITREA/Index.htm) makes it possible to utilise the results of analyses conducted in the Czech Republic and abroad. The database was developed as part of the ongoing project, some of the results of which are presented in this article.

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English by *David J. Gaul*

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Helenistické mosaikové skleněné nádoby v Čechách a na Moravě

V nálezovém fondu mladší doby laténské v Evropě se setkáváme kromě běžných skleněných ozdob výjimečně také se skleněnými nádobkami, které patřily k luxusnímu importovanému zboží. Na tomto místě se zabýváme polychromními mosaikovými nádobami zhotovenými technikami millefiori (stěny sestaveny z vícebarevných elementů – řezů tyčinek), reticella (ze spletených vláken) a technikou páskového/achátového skla (z jednotlivých pásků nebo velkých řezů tyčinek). V Čechách a na Moravě se tyto nádobky vyskytly ve třech lokalitách (*obr. 1*) v celkovém počtu 17 kusů: na oppidech Stradonice (3 nádoby) a Staré Hradisko (13 nádob) a na hradišti púchovské kultury Jičina-Požaha (1 nádoba). Ve všech rekonstruovatelných případech jde o malé nečleněné misky (průměr ústí 100–125 mm) oblých stěn se slabě zataženým okrajem nebo kónické misky s rozevřeným okrajem (*obr. 2*; *3*), které sloužily pravděpodobně jako součásti picích servisů.

Kulturní a chronologický kontext. Millefiorové nádoby z Čech a Moravy mohou podle typologických charakteristik patřit skupině Canosa (konec 3. až konec 2. stol. př. Kr.) nebo skupině Antikythéra-Délos (konec 2. stol. až 70 př. Kr.). Millefiorové nádoby byly vyráběny i nadále v augustovském a imperiálním období a dále až do 5. stol. po Kr. ve víceméně stejném nebo podobném technickém a barevném provedení; postupně se obměnil jen tvarový sortiment nádob. Formálně nediagnostické zlomky nečleněných millefiorových misek, zejména z augustovského období, lze odlišit od starších jen nesnadno. Misky typu reticella z moravských nálezů patří staršímu typu, který se vyznačuje spirálovitým stočením zkroucených dvoubarevných vláken horizontálně, resp. paralelně s okrajem. Byly vyráběny od konce 3. stol. př. Kr. Achátové sklo s různě zvlněnými pásky bylo snad míněno jako nápodoba polodrahokamů. Je známo od konce 2. stol. př. Kr. Toto chronologické zařazení odpovídá českým a moravským nálezům, které patří do LT C2-D.

Evropský kontext. V českých zemích nalezené mosaikové nádobky jsou podle svých typologických vlastností nejpravděpodobněji výrobky 2. až počátku 1. stol. př. Kr. To je také doba značného nárůstu nálezů mosaikových nádob obecně, která je odrazem jejich daleko vyšší produkce než dříve. Je známo, že mosaikové nádoby, zejména misky, jsou rozšířené v helenistickém světě všude tam, kde byla poptávka po luxusním skle. Současné soupisy zahrnují několik desítek lokalit ve Středomoří od Itálie po syropalestinskou oblast a v Černomoří. Největší kolekci helenistických mosaikových nádob o téměř stovce kusů poskytl ostrov Délos, kde se nicméně nepředpokládá jejich místní výroba (*Nenna 1999*). Příslušné sklozpracující (sekundární) dílny se hledají v Egyptě či Egeidě, pravděpodobně nikoli na syro-palestinském pobřeží, odkud však mohlo pocházet surové sklo. V této době totiž v Bejrútu pracovaly primární dílny s obrovskými sklářskými pecemi; další se předpokládají v Sýrii či na Rhodu (*Henderson 2013*).

Nálezy helenistických mosaikových nádobek v laténské (*předřímské*) *Evropě*. Současný soupis (*obr. 4*) zahrnuje 10 lokalit; jejich skutečný počet byl jistě daleko vyšší. Nálezová situace je nutně zkreslená velkou fragmentarizací a špatnou dochovatelností fragilních nádobek; drobné, často korodované skleněné střípky mohou unikat pozornosti při použití ne dosti jemných exkavačních metod, nebo nejsou správně klasifikovány. Nápadný je velký počet (13) nádob ze Starého Hradiska na Moravě, který nepochybně souvisí s polohou tohoto oppida na frekventované obchodní cestě – Jantarové stezce. Ve srovnání s tím je počet mosaikových nádob na Manchingu poloviční. Větší množství nádob je známo pouze z Mont Beuvray (15 ks), kde ale není jasné, jakým procentem se na tamějším souboru podílejí mosaikové nádoby augustovského období.

Chemické složení mosaikových nádob. Všechny dostupné a dostatečně zachované zlomky mosaikových nádob z Čech a Moravy byly podrobeny chemickým analýzám. Jejich cílem bylo porovnat tato skla jednak se sklem helenistických mosaikových nádob nalezených ve Středomoří, jednak s laténským sklem, které se vyrábělo v Evropě, i když zřejmě z importovaného skla původem nejspíše ve východním Středomoří (*Henderson 2013*). Celkem bylo analyzováno 36 vzorků skel různých barev z mosaikových nádob a 6 srovnávacích vzorků z laténských náramků a prstencových korálů. Velké série chemických analýz laténských skel jsou k dispozici z Čech, Moravy a dalších částí Evropy, analýz mediteránního skla je podstatně méně. Všechny vzorky byly analyzovány metodou SEM-EDS (V. Hulínský, Š. Jonášová). Ke zjištění stopových prvků byla u vybraných skel provedena ještě neutronová aktivační analýza (NAA, J. Frána a M. Fikrle) a u dalších také laserová ablace (LA-ICP-MS, T. Vaculovič). Výsledky uvádějí *tab. 1–3*.

Závěr. Nálezy helenistického mosaikového skla se řadí k poměrně velké skupině středomořských importů období LT C2-D. Z chemického hlediska byly mosaikové nádobky zhotoveny ze sodno-vápenatého natronového skla a obsahem stroncia, zirkonia a barya se jejich sklo podobá současným sklům z levantského pobřeží. To platí i pro laténský skleněný šperk. S ním se mosaikové nádoby shodují také barevnými odstíny skla, resp. použitými koloranty. Rozdíl byl shledán v opakním žlutém skle. To bylo v mosaikových nádobách barveno antimonem, tedy podle starší tradice barvení žlutého skla, která charakterizuje halštatská a laténská skla až do 3. stol. př. Kr. včetně. Ve žlutých mladolaténských sklech od 2. stol. př. Kr. byla použita jiná technologie barvení a kolorantem je tu cín. Zatímco v laténské Evropě pracovala řada sekundárních sklářských dílen produkujících skleněný šperk, nelze předpokládat, že by tu docházelo také k výrobě sofistikovaných mosaikových nádob.

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