Prejeto / *received*: 27. 4. 2022. Odobreno / *accepted*: 30. 6. 2022.
CC BY-NC-ND 4.0, DOI: 10.3986/dmd19.2.05

ORIGINAL, FAKE, OR A LITTLE OF BOTH?
ON THE QUESTION OF THE AUTHENTICITY OF A PANDURINA BY GIOVANNI SMORSONE

HEIDI VON RÜDEN
Staatliches Institut für Musikforschung Preußischer Kulturbesitz, Berlin

Izvleček: *V muzejski zbirki Državnega muzikološkega inštituta v Berlinu se nahaja pandurina, ki jo je izdelal Giovanni Smorsone. Glasbilo je v zbirko prišlo iz kroga violinskega ponarejevalca. Raziskave so pokazale, da vendarle ne gre za ponaredek, kljub temu da so bile odkrite nekatere spremembe na glasbilu, ki se ne skladajo z izvirnim glasbilom.*
Ključne besede: *pandurina, mandora, organologija, mikroračunalniška tomografija, Giovanni Smorsone*

Abstract: *The Museum collection of the Staatliches Institut für Musikforschung in Berlin houses a pandurina built by Giovanni Smorsone. However, this instrument came to the museum from within the circle of a violin forger. Investigations have proved that it is not a forgery. Nevertheless, alterations were found that do not match the original state of the instrument.*
Keywords: *pandurina, mandore, organology, micro-computed tomography, Giovanni Smorsone*

Introduction

The pandurina (also "mandore" in English) is a small plucked instrument with its body resembling that of a lute. It has a five- or six-course stringing with strings made from gut and a soundboard with a rosette covering the sound-hole, often being richly decorated with engravings on the fingerboard. In sonatas, concertos or arias pandurinas played upper parts or replaced the violin or flute. In the eighteenth century they belonged to an aristocratic environment. Today, examples can be found in many museums and collections in Europe, the USA and Asia.

When a pandurina from the collection of the Museum of Musical Instruments in Berlin was included in an exhibition entitled *Status Macht Bewegung* in 2020, a report on its condition was made, and documents relating to the object were examined. Its provenance was placed in doubt for the first time on account of discrepancies in some features of its design and construction. Was the instrument original and made in a workshop in Rome in the eighteenth century for a noble family, or was it (re)made in the 1960s in Switzerland for the seller, Henry Jean Werro, whose father was a known violin forger?

The descriptions of pandurinas in catalogues are very helpful for an initial comparison, but detailed questions regarding constructional features, the bracing, bridge measurements and the signature label cannot be answered adequately simply via the existing literature.

With imaging techniques such as micro-computed tomography (micro-CT) it has proved possible to investigate constructional features of the Berlin pandurina. Other analyses were also carried out – including chemical analyses, which required a small amount of sampling. During this work further questions arose, which in turn led to new approaches to the investigation.

It is one of the perennial tasks of a museum to ascertain and establish the provenance of its holdings. In collections of musical instruments forgeries are sometimes uncovered. Some features of this pandurina raised questions about its authenticity as a complete object without modifications. During the work of documentation the specifics first became clear through observation based on long professional experience.

Results of different analyses were collated to clarify the origin of the pandurina in the Berlin collection (Inv.-No. 5005). The present paper highlights the scientific methods used for these analyses. Three-dimensional micro-CT as an imaging technique played a major role in answering some questions. The images obtained were evaluated and used for measurements and calculations. Some investigations were carried out by specialized institutions.

The results of the studies presented in this paper help to classify the object, but at present they cannot be used as proof of the age and authenticity of the instrument. Moreover, some findings are hypothetical. The practice of counterfeiting musical instruments has been around for many centuries. A good imitator can falsify the history of instruments by using old materials, pasting fake labels or establishing a false provenance. Even patches of parchment or wood have been glued onto fake instruments to create the illusion of an antique object. The techniques of forgery pertaining to bowed instruments have also been applied to plucked instruments. But perhaps this pandurina has been reconstructed without any intention to deceive.

A guide towards the recognition of counterfeiting in organology is the book *Die Geige* by Hermann Drögemeyer, published in 1903. There, the author describes the practices of the counterfeiting market very precisely (but not with any intention to teach violin-makers how best to create fakes!). In his third chapter he explains the conditions under which it is possible to breed woodworm larvae in a finished instrument in order to simulate a particular age of material:

> [U]nd man ist bei Instrumenten, die später einen höheren Wert repräsentieren sollen und die dementsprechend auch besser, resp. täuschender gearbeitet sind, gezwungen, sie einer zwar längeren, aber auch sichereren Prozedur zu unterwerfen, um echte Wurmlöcher zu erzeugen. Um dies zu erreichen, bringt man die fertig imitierten und lackierten Instrumente in eigens dazu angefertigte Kisten aus altem, wurmstichigem Tannen- oder besser Buchenholz – die Franzosen benutzen vorzugsweise des günstigeren Erfolges wegen das Holz des Elsebeerbaumes (Sorbus torminalis) und des weißen Elsebeerbaumes (Sorbus aria) –, legt sie schichtenweis zwischen alte, den Holzwurm in sich bergenden Stücke Tannen-, Buchen-, Linden-, Ahorn und Birnbaumholzes und füllt die Zwischenräume mit altem Mulm aus Holzställen gut aus. Ganz dasselbe ist vorher mit dem Innenraume der Instrumente auch geschehen. Ist die Kiste soweit hergerichtet, so wird sie gut verschlossen und an einem warmen, ruhigen und dunkeln Orte aufbewahrt. Je nach dem Grade der Zerstörung, die man erreichen will und dem reichen

Inhalt an Holzkäfern (Anobium pertinax) und deren Larven, werden die Instrumente ½–1 Jahr und länger gelagert.[1]

It should be borne in mind that craftsmen are able to make (or rebuild) very good imitations, and that the purpose of a forgery, as in the art market, is often to launder money. In the environment of a flourishing violin trade the practice of forgery cannot be considered unusual.

The Smorsone Pandurina in Berlin

A pandurina is a small lute belonging to the mandora family. It became the forerunner of the Milanese mandolin. Museums use the terms pandurina, mandolino, mandola, mandolin milanaise, Baroque mandolin or liuto soprano for this kind of plucked instrument. The museum in Berlin uses the name pandurina.

The subject of this paper is a pandurina that was made in the eighteenth century by Giovanni Smorsone in Rome. In the early history of the mandolin, in the middle of the seventeenth century, this type of mandora was strung with gut, had four or five courses, a bridge glued onto the soundboard and frets made of an organic material. In the older types the frets were tied like the frets of a lute. The instrument could be played with fingers or a plectrum, and its music was notated in tablature. A manuscript with dances featuring a pandurina, dating from the seventeenth century, can be found in the library of the Conservatory of Music in Florence.[2]

At the beginning of the eighteenth century the compass of the pandurina expanded through a six-course stringing. The instrument found a place in small ensembles and took treble parts in sonatas or concertos. In Italian compositions one usually finds the term “mandolino”, not “pandurina”. This high-pitched type of instrument (with the compass g–c‴) played a role in Antonio Vivaldi’s oratorio *Juditha triumphans* (1716), instrumental works by the composers Giovan Pietro Franchi (*c.* 1700) and Johann Adolf Hasse (1733) and ones by the England-based composers Willem Defesch (*c.* 1745) and Nicolas Cloes (1749). With the emergence of the metal-strung Neapolitan mandolin, which stabilized its form near the end of the eighteenth century, the construction of the gut-strung mandolin died out.

A five-course mandolino was made by Antonio Stradivari in Cremona in 1680. Today this example is housed in the National Music Museum (Inv.-No. NMM 6045) in Vermillion (SD), USA.

A few dozen Roman mandolinos made during the first third of the eighteenth century are held by different museums around Europe, the USA and Asia. The most famous Roman makers were Giovanni Smorsone, Benedetto Gualzatta and Domenico Pistachi. Certain characteristics can be observed commonly on these instruments: the end of the cap have been shaped similarly; decorative materials have been chosen for the shell; and

---

1 Drögemeyer, *Die Geige*, 198.

2 “Danze”, a monograph containing handwritten music.

elements made of mother-of-pearl have been engraved (for example, overlays on the fingerboard can show hunting scenes). The aesthetic aspect was important in their design. Most Roman pandurinas of that period have a carved rosette made of the same wood as the soundboard and a handwritten label. The number of strings, the string lengths, the size of instruments and the position of the bridge vary slightly.

According to the label, the maker of the pandurina is Giovanni Smorsone, and the place and date of origin is Rome 1736 (see Figure 1). The pandurina has a soundboard of spruce and a shell made of ebony and bone. The stringing is fastened on the head with twelve lateral pegs. The bridge is glued onto the soundboard. The fingerboard has inlaid frets. The shell, fingerboard and neck are decorated with engravings in a floral style, and the fingerboard is additionally engraved with a hunting scene, which fits the assumed origin of the instrument as belonging to a Florentine noble family (see Figure 2). Similar floral ornamentation adorns an associated instrument case covered in leather. The gilded insignia on the case shows a tree on a trimount (a stylized heraldic depiction of three mountains) with stars on each side and two angels holding a crown above it. The pandurina is internally reinforced with a printed paper, possibly dating from the seventeenth century, known to have been used for contemporary printed treatises.

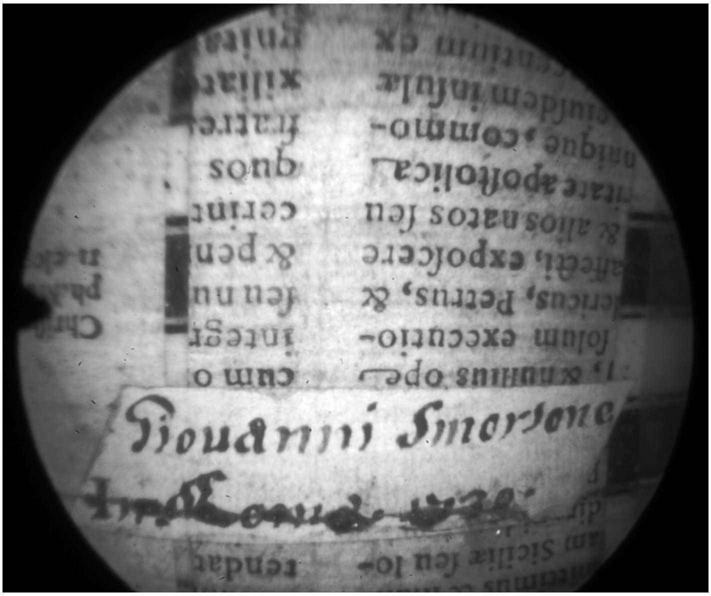

Figure 1
The handwritten label of the pandurina of Giovanni Smorsone, Rome 1736 (Musikinstrumenten-Museum Berlin, Inv.-No. SIMPK 5005). Photo: Heidi von Rüden.

In 1967 the violin-maker Henry Jean Werro from Bern in Switzerland sold this instrument with its case to the Staatliches Institut für Musikforschung Preußischer Kulturbesitz (SIMPK) in Berlin. Earlier, in 1953, a trial had taken place where Henry Werro, the father of Henry Jean Werro, was convicted of forgery and embezzlement. The close connection of the Werro family to this pandurina is what gave rise to the investigation.

Figure 2
The pandurina of Giovanni Smorsone, Rome 1736 (Musikinstrumenten-Museum Berlin, Inv.-No. SIMPK 5005). Photo: Heidi von Rüden.

A violin-maker is trained to imitate the historical appearance of instruments by using old materials, pasting fake labels or falsifying provenance. This pandurina was very well preserved, an indication that it was probably always kept in its case. Images show that the case was heavily infested with woodworm larvae, which raises the question of why there are no traces of woodworm infestation in the instrument. Why is the constructional technique for many parts of the instrument executed masterfully (as in the shell and the neck), yet in other places badly (as in the design of the bridge and the fitting of the shield on the head)? Is the patch glued under the bridge placed there because of a crack or, alternatively, to give the illusion of this pandurina as an antique object? Perhaps the soundboard of this instrument was rebuilt without any intention to deceive. However, there are other aspects that give us cause to examine more deeply the constructional characteristics and material specifications of this pandurina.

The different scientific methods that were used to find evidence of traces of falsification or remodelling are listed in Table 1. A stylistic evaluation (using historical analyses) detailing further important results of the investigation was carried out by Antje Becker.[3]

[3] Becker and von Rüden, "Original, Fake or a Little of Both?"

Table 1
Scientific methods and their application.

Methods	Question about features
Dendrochronological analysis	Time of manufacture
Proportion analysis	Design and construction; dimension ratio
Endoscope	View inside the instrument for label and printed lining paper
FTIR	Determination of material in engravings
Measurements and calculations	Temperature (fretting system) String tension Dimension of holes
Microscope	Determination of material and marks from tools
Raman spectroscopy	Determination of material in engravings
3D micro-CT scanning as imaging technique	Bad fitting of components Determination of unusual material Marks from tools and old repairs Woodworm Craftsmanship Structure Fretting system Dimensions of holes Dimension ratio
UV light	Determination of unusual material Marks from tools and old repairs

Scientific Methods in Restoration

Micro-computed tomography (micro-CT) is an imaging technique for three-dimensional (3D) objects. The object is trans-illuminated, and the different materials are displayed in shades of grey according to the density of the materials. The object is mounted on a “turntable” that rotates while a very strong light source shines through the object. As with a digital camera, the image created by the emerging beam is then captured by a sensor. Figure 3 shows the micro-CT scanner of the Bundesanstalt für Materialforschung. The instrument is positioned on the rotating table for scanning. The light source is on the left, and the sensor that saves the images is on the right. This scanning method is almost contact-free. An examination of the inside of the object is possible, allowing the detection of structural features and damage. From the high-resolution images precise measurements can be made (see Figure 4).

There are some disadvantages to CT scanning, such as the confusion of material boundaries due to light scattering, the high costs and the long duration. Further, the scanner is not on site. The object needs to be securely mounted and fastened to the turntable. Additionally, a large amount of space is needed to store the data. The resolution processed

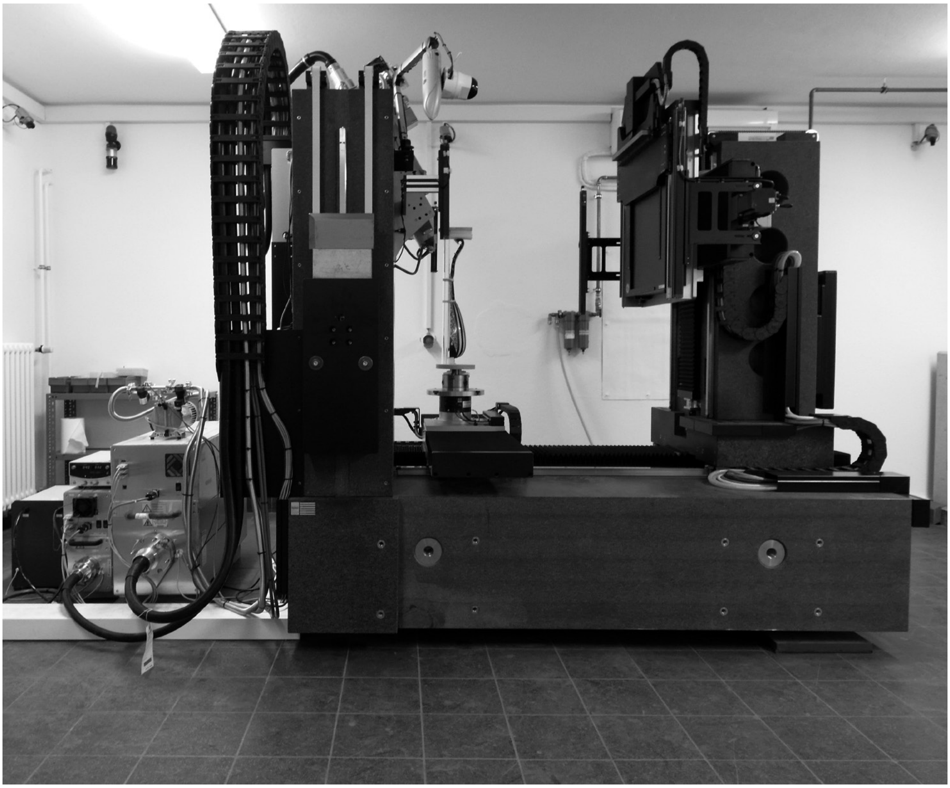

Figure 3
The phoenix v|tome|x L 300/180, a 3D micro-CT scanner produced by GE Sensing & Inspection Technologies (now Baker Hughes Digital Solutions GmbH) located in the Bundesanstalt für Materialforschung (BAM) in Berlin, Germany. The pandurina is fixed in place on the rotating table. X-ray tube used: XS 300 D (max. 300kV), reflection target, focal spot: >10µm. Detector: flatpanel 2k, 200 µm pixel pitch. Photo: Heidi von Rüden.

from the scan is insufficient to determine the type of wood, as would be possible with a microscope. But at least, discrete material samples can produce comparable impressions. The free program myVGL[4] was used to read and measure the CT data (hereafter referred to as "the images").

Other devices and methods were used to answer many questions relating to this investigation. In dendrochronology the climatic condition plays a big role. This is a method to determine the growth period of spruce or fir. Dryness, humidity and cold or hot seasonal temperatures leave an imprint on the annual rings of the wood. Where resonance wood grows in Europe, there are different climatic zones. Specialists can make comparisons between many chronologies to arrive at the most accurate assessment possible. To do this, they measure the distances between the annual rings.

4 myVGL is the name of a free viewer for 3D data from Volume Graphics GmbH in Heidelberg.

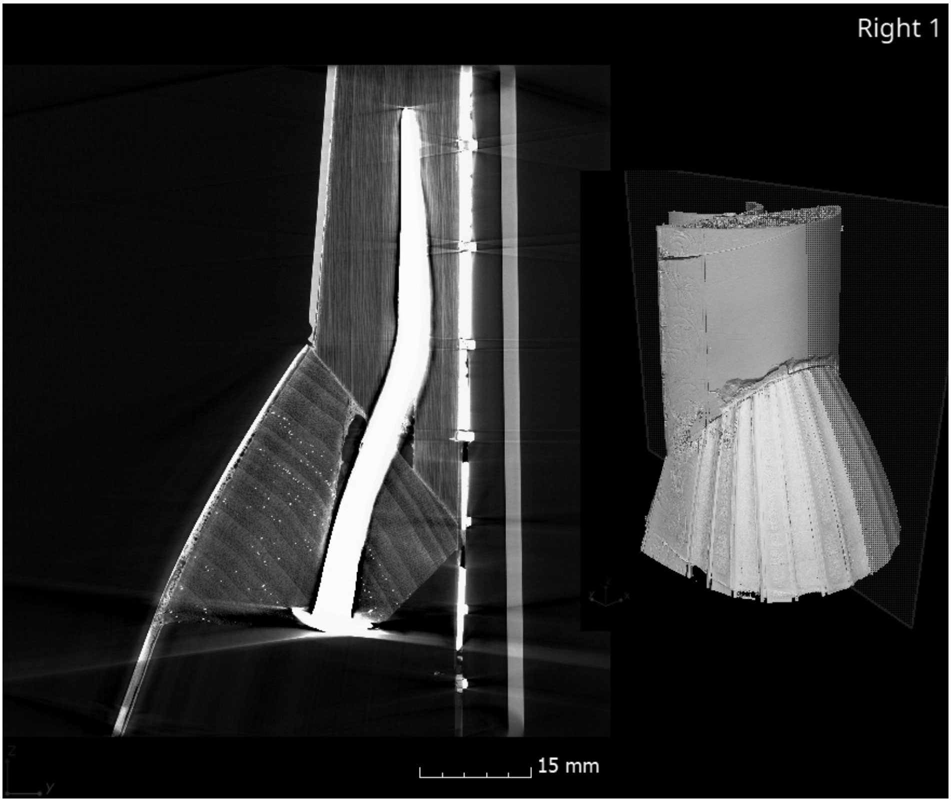

Figure 4
This image is from a micro-CT scan. The connection between the neck and the body is strengthened by a nail. Shadows emanate from harder materials (metal, mother-of-pearl), which is why the image data must be interpreted very carefully. Image: SIMPK.

With a rod endoscope it is possible to look past the rosette into the inside of the body of the pandurina. It is then possible to scrutinize the label and take photographs. Ultraviolet (UV) light can detect evidence of retouching and old repairs. A microscope will show marks from work or through damage in greatly magnified form. If sample material is available, it can be used to determine the wood species. It facilitates the differentiation of material, such as between ivory and bone or between spruce and fir. For dimension and proportion analysis the method of Herbert Heyde, published in *Musikinstrumentenbau* in 1986, was applied.

Many museums and collectors generously provided data from comparable objects to work with in the investigation. Further, various computations were made. The string tension was calculated using Taylor's theorem, which can express the movement of a vibrating string mathematically.[5] The formula for this is composed of various parameters: the density of the string material, the vibrating string length, the frequency (pitch) and the

5 Taylor's formula used to determine the form of movement in vibrating strings: $f_n = \frac{n}{2l}\sqrt{\frac{\sigma}{\rho}}$.

diameter of the string. To allow a comparison of musical intervals, the fret spacing was converted to cents using a different formula. The formula for calculating temperaments resulting from string length tapped on the fingerboard by fixed frets is the following:

$$x[cent] = \frac{1200}{\lg}\left(\frac{L}{L + \Delta L}\right)$$

Some sample material was taken for the application of two general analytical laboratory methods, namely Raman spectroscopy and Fourier-transform infra-red spectroscopy (FTIR):

> Raman spectroscopy is a method that makes it possible to identify organic or inorganic molecules or crystals contained in the sample using comparison spectra. The sample is irradiated with monochromatic light (laser). Fourier-transform infrared spectroscopy is a method for identifying molecules. Infrared light falls on a small sample and a detector registers the light that passes through the sample. The infrared causes vibrations between the atoms of the sample and leads to the absorption of certain light waves.[6]

Applied Methods and Checked Elements

The various methods of analysis can be used to clarify ambiguities. Most of the investigation's results validate the age and authenticity of the pandurina. Even though, at present, all the various marks of manufacture cannot be interpreted up to the last detail, the instrument fits well into the series of other instruments by the maker Smorsone, and the label in the instrument is most likely old.

Dendrochronology

An expert drew up a dendrochronological report regarding the age of the soundboard.[7] The spruce was grown in the northern Alpine region. This investigation showed that the processed wood of the soundboard is old. The tree grew in the period around 1600 – more accurately, the youngest growth ring was determined to be from 1629. Thus the wood could have only been processed around 1630 at the earliest. The woods were processed relatively promptly, within a few years of the felling date. The top is very thin, less than 2 mm, so this resonance wood would have been sufficiently dry after only a short time. It is unusual for an instrument maker of the time to store wood that is a hundred years old, but a good imitator would always use very old wood to mimic old instruments.

There is also another possibility regarding the use of this very old material. The instrument is very narrow, so an area belonging to the tree trunk is not used for the instrument's body: the dendrochronological curve probably originates from a part of the wood that is fifty or a hundred years older. This would therefore correspond to the age

6 For details, see "Rathgen-Forschungslabor".

7 Beuting, "Gutachten zur dendrochronologischen Altersbestimmung".

of the pandurina, which is claimed to have been built in 1736, but unfortunately the last digits of the handwritten label are very difficult to read (see Figure 2). The soundboard, too, could have been taken from an older instrument.

The material used can help to determine the origin when instruments from a single maker are compared. In the field of musical instruments it has often happened that spruce and fir are confused. This has led to incorrect results in dendrochronology. Nowadays, the difference between coniferous wood with and without resin is taken into account in the investigations.

Confusion between, or inadequate determination of, the materials ivory and bone also occurs. The Smorsone pandurina was built from various woods and organic materials, such as spruce, ebony, tortoiseshell and mother-of-pearl. The bright shavings of the shell are made of bone, not ivory as previously recorded. The pores of the bone are visible in the digital images. A lute shell made of bone is very rare and an unusual feature of this instrument. There is a pandurina made by Smorsone in a collection in Tokyo that looks quite similar, having, for example, tortoiseshell at the back of the neck, and, according to the catalogue, shavings of ivory. However, the available information about materials relating to other collections can sometimes be incorrect.[8] It is possible that other collections have misidentified the light-coloured material of the ribs and confused bone and ivory. If other pandurinas by Smorsone are likewise made of bone and ebony, and not of ivory and ebony, this would be an indication of the authenticity of the Berlin instrument. Because of its higher aesthetic status, ivory has probably often been named too readily, in preference to bone, in descriptions of instruments. Descriptions of materials have to be examined very carefully before comparative statements are made about them.

Signatures

On the pandurina there are various characteristics that, like signatures, can be assigned to the manufacturer or the owner. On the accompanying case, gilded ornamentation is embossed into the leather. It shows a crown held by two angels above a tree over a trimount. This is framed by a quantity of foliage that is also reflected in the design on the instrument. The coat of arms points to a noble family from Florence. Further investigations are still pending. On the fingerboard of the instrument scenes of a hunt are engraved in the mother-of-pearl, a fact that likewise bespeaks a noble origin. The illustrations of hunting scenes can be found on many instruments made by both Smorsone and Gualzatta.

A small shield on the head of the pandurina bears the symbol of a double-headed eagle, as does the rosette in the soundhole. A crack is visible in the middle of the rosette. Normally, a luthier would not weaken this part by carving along a year ring. The rosette is not supported with four small braces as in other examples. The double-headed eagle is believed to be a reference to the Roman maker. One can find similar double-headed eagle ornaments on other lutes. The soundboard may possibly have been remade at a later point, something also suggested by the different bracing and the strange finish of the rosette and emblem at the head.

---

8 Funayama, Uchino and Honma, *Catalogue of the European Musical Instruments*, 72–73, 196, 198.

Shield

A rectangular shield made of a small mother-of-pearl plate engraved with a double-headed eagle is glued at the end of the pegbox. The shield could be a later reworking; it possibly covers over a different mark. Under UV light, there are parts visible in orange; the colour indicates repairs with shellac. There are other areas on the side of the pegbox that also stand out in orange.

Figure 5
Photo of the small shield of the head with a double-headed eagle (Musikinstrumenten-Museum Berlin, Inv.-No. SIMPK 5005). Photo: Heidi von Rüden.

Engravings

Noticeable are various finishes in the engravings on the ribs of the bone part of the shell and on the mother-of-pearl fingerboard. Is there evidence of different working techniques? Were the ornaments perhaps executed at different times by different workshops? The images of the 3D scans show the engravings from another perspective – a cross-section. By this means, tool marks and profiles of tool knives or files become visible. Certain engravings were made with a pointed tool, others with a round one (see Figure 6). A comparison shows that the tool marks are very similar in the bone and the mother-of-pearl. The marks in the mother-of-pearl are deeper than those in the bone; however, the density of bone is different from that of mother-of-pearl or wood: bone is hard, more brittle, and a bit fibrous. Mother-of-pearl is much more homogeneous and easier to work with. This is how we interpret the unclear, jagged lines seen on the ribs of the shell made of bone (see Figure 7) but not in the engravings on the mother-of pearl.

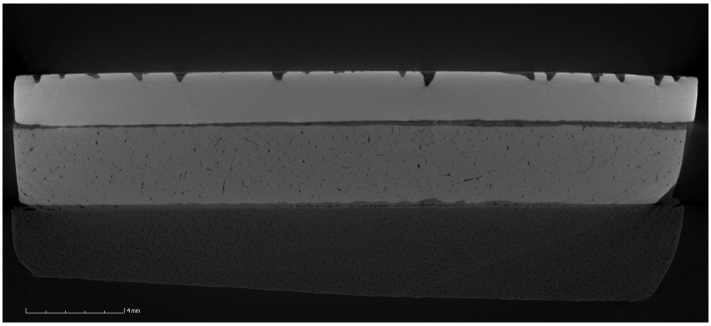

Figure 6
This image is from a cross-section micro-CT scan. A small plate of bone is glued between the platelet and wood of the pegbox. The fitting is not good and does not appear to be the original. (Image: SIMPK).

Figure 7
Bone is a hard and brittle material. This is an image taken with a digital microscope of a sample of the black filling material that was taken from the engraving of one rib (Musikinstrumenten-Museum Berlin, Inv.-No. SIMPK 5005). Photo: Heidi von Rüden.

Raman Spectroscopy and Fourier-Transform Infrared Spectroscopy (FTIR)

All the engravings are blackened. The black pigment in the ornament is carbon (soot). It was detected in a sample via Raman spectroscopy. In addition, a proportion of a modern restoration material was found during analyzation with FTIR.[9]

Similarly to the comparison of the tool marks in cross-section, the intention was to use the Raman method to test whether the black pigment in the mother-of-pearl and bone had different compositions. Because this is soot in both samples (i.e. pure carbon), a differentiated statement is not possible. One can read from the result only that carbon is present in both samples, but one does not learn anything about the concentration: there is no method to distinguish carbons from each other. The laboratory suggested another method: to examine other particles with FTIR. Using this method, in the second sample, which was taken from the engraving on the side of the lute shell (i.e. the engravings in the bone), the modern restoration material polyvinyl acetate (PVAC) was found. PVAC preparations are used as adhesives for wood or other materials. The detection of PVAC indicates that work has been done on the instrument more recently. Perhaps this is an indication of a repair that occurred before the instrument came to the museum.

Stringing

Bridges of lutes and guitars often have drill holes of different sizes with multiple distance space – one hole for each individual or pair of strings. The strings are tied to the bridge. The pandurina also has this bridge shape but not the pronounced different-sized holes. There are just two different hole diameters in the bridge of the pandurina. That for the low strings has a diameter of 1.5 mm; those for the other three pairs of strings have one of 1.1 mm. These diameters are unusually large for the time.

A string's diameter can give information about the maximum string tension. Around 1736 there were already gut strings with wire windings in use. For the low frequencies, they have a better sound than plain gut strings because the core of the string can be made thinner and therefore will vibrate better with the same mass (because of the metal covering). Strings were very expensive, and the selection of suitable strings was important. The fastening of the string is very sensitive and vital for a good sound.

Table 2 shows a suggestion for stringing the pandurina with plain gut strings. For the purposes of the calculation, diameters between 1.5 mm for the lowest, and 0.45 mm for the highest, string were chosen. The string diameters were calculated starting from the largest possible diameter of the lowest string (1.5 mm) and a tuning pitch a′ = 413.5 Hz, as plain gut strings. For a scale length of 332 mm, string-tension forces between 3.4 kg and 4.9 kg are obtained. Therefore, the large hole size in the bridge of the pandurina is not necessary, and it would have a disadvantageous effect on the sound, although it would make it easier to try out different string gauges. This could be an indication that the bridge was modified during the lifetime of the instrument. The large holes would enable one to use thicker single stringing instead of double stringing – the relatively large holes leave a lot of room. From a musician's point of view, it would be better to match the holes precisely to the string diameter. With smaller holes, the purity of the tuning would be

[9] Aibéo, Pausewein and Simon, "Untersuchungsbericht 6_012621".

better. But experimenting with the different string parameters is easier with larger holes. These considerations do not take the various possible playing techniques into account: with or without a plectrum, with a support finger or with nails. Perhaps, in the nineteenth century, the owner played guitar and adapted this instrument accordingly. Mathematically, it is possible to select the g string as a plain gut string with a diameter of 1.5 mm.

Table 2
String diameters calculated with the formula: Fz [N] = 3140 ρ [g/cm³] L² [m]² f² [kHz]² d² [mm]².

Pandurina SIMPK 5005	**g**	**h**	**e′**	**a′**	**d″**	**g″**
String diameter (mm)	1.5	1.2	0.95	0.72	0.55	0.45
String material (g/cm³)	1.276	1.276	1.276	1.276	1.276	1.276
Tuning pitch a′ (Hz)	415.3	415.3	415.3	415.3	415.3	415.3
String tension (N)	33.6	34.11	38.09	38.96	40.51	48.38
String tension (kg)	3.43	3.48	3.88	3.97	4.13	4.93

It is possible to measure the vibrating string length very exactly with the myVGL program. The lengths were converted into the pitch system of 100 cent per semitone, using the formula given on page 109. From the measurement of the fret spacing on the fingerboard, no temperament contemporary with the eighteenth century can be established. The fret pitch is laid out evenly according to equal temperament, as used in the nineteenth century. This fretting does not lead to an obvious conclusion with regard to any historical tuning.

Damage and Old Repairs

The neck of the pandurina fits into the shell with assistance from a nail (see Figure 4). In an old restoration report for the pandurina in the museum of the Royal Academy in London, there is mention of a neck block that is heavily split.[10] This feature is absent from the Berlin instrument, since only two very small cracks are visible in that part.

A small circular repair patch is glued under the right side of the bridge. Probably made of parchment, this has a thickness of 0.6 mm. There is a small hole in the patch as well as the remaining part of an old knotted string. Presumably the repair was made with the pandurina in a sealed state, and the patch was pulled with a string against the soundboard. There is a comparable circular patch seen on a pandurina in Nürnberg.[11] Small circular patches have been used for a long time in the making and repairing of lutes. In 1676, in *Musick's Monument*, Thomas Mace wrote about this use: "[a]nd then with little pieces

[10] See instrument: Mandolino, Giovanni Smorsone, Rome 1724, Royal College of Music Museum, London, Inv.-No. RCM0107, https://mimo-international.com.

[11] See instrument: Pandurina (Mailändische Mandoline), anon., Mailand 1690, Germanisches National Museum, Nürnberg, Inv.-No. MIR873, https://mimo-international.com.

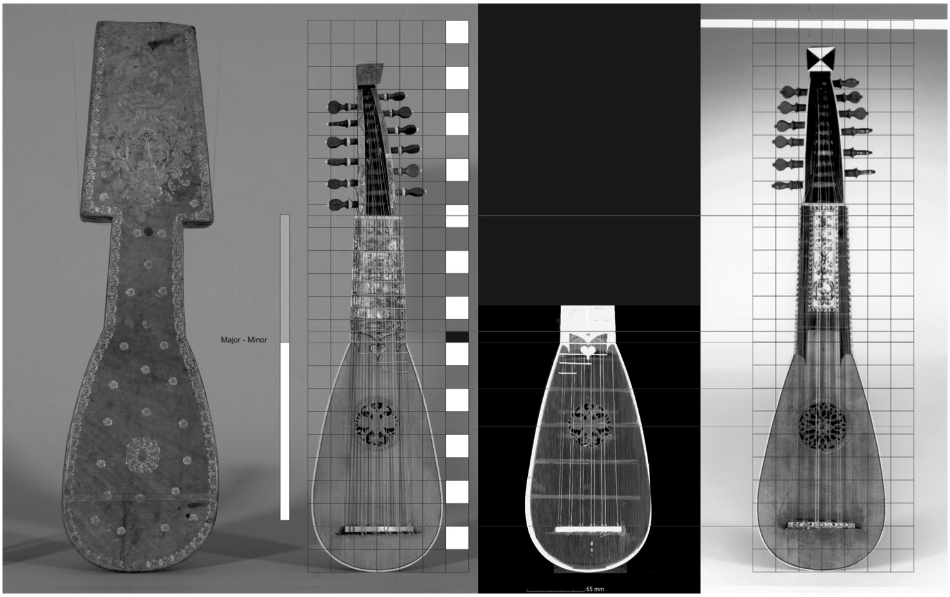

Figure 8
Photo and micro-CT scan of the Berlin pandurina by Smorsone (left) with a Roman scale of 1 Roman *oncia* = 24.82 mm (Musikinstrumenten-Museum Berlin, Inv.-No. SIMPK 5005). Photo: Heidi von Rüden. Next to it, the mandolino (Smorsone, Rome 1724) in the London collection (Royal College of Music Museum, Inv.-No. RCM 0107). (Public domain).

of Paper, (so big as pence, or two-pences, wet with Glew) cover all the upper Flat in the Joynts".[12] Repair receipts were another means of faking age.

Proportions

The lute makers worked with units of measurement different from those used today. Millimetres were not yet known. Each region and city had its own system of measurement. Sometimes the craftsmen took the customary units of measure learned during their apprenticeship to another town where they later worked. It is always tricky to find the right historical unit of measurement if no tools of the instrument maker have been handed down. Proportional analysis helps one to "crack" the measurement systems of another age. Among the examples of a dimensional musical-instrument analysis by Herbert Heyde, there is one for a pandurina from the instrument collection of the Händel-Haus in Halle.[13] Heyde used the new Roman foot for this analysis: an *oncia* (a smaller unit of a Roman foot) measures 24.82 mm. This measurement unit results in simple proportions, which can easily be constructed with the help of a compass. The approach of using the Roman measure was chosen for a proportional analysis of the Berlin pandurina. This led to the conclusion that the pandurina's inner soundboard stands in a ratio of 3:4 to

[12] Mace, "Second, and Civil Part", 60.
[13] Heyde, *Musikinstrumentenbau*, 99–101.

the string length. Moreover, the soundboard's measurements obey a Golden-Section ratio. The string length can be divided into the major and minor portions of the Golden Section, the break occurring at the point where the neck is attached to the body. So the neck begins concurrently with the minor portion of the string length. The proportions of the pandurinas in London and Berlin were compared using this method (see Figure 8). It was found that the position of the rosette and the bridge differed between the two instruments. This is strange for instruments from a single workshop whose construction phases are not far apart in time.[14]

With regard to the proportions of different instruments, precise measurements are necessary. It is not yet possible to make detailed statements about the proportions between different instruments, because that would require measurements to be taken of the instruments using an identical system of measurement as well as photographs of very high quality, none of which is available. According to existing data, the five pandurinas from the Smorsone workshop all differ in size and string length.

In comparison with older instruments of this type by makers from other regions – for example, a mandolino from Stradivarius – it is observable that the number of strings has changed from 5 × 2 strings to 6 × 2 strings over the decades. Also, the strings have become longer. The same evolution occurs for many lute instruments of that period.

Conclusion

According to these investigations, the pandurina from Smorsone in the Berlin museum is very likely not a forgery. Results from dendrochronology accord well with the information on Smorsone's life. The investigation shows that there has most probably been some reconstruction on portions of the pandurina. The bridge, soundboard and platelet at the head bearing the double-headed eagle could have been replaced at some point. When compared with illustrations in catalogues, this Smorsone pandurina appears to differ slightly in size and shape. A comparison with other instruments will become more informative if performed on-site with style-critical methods; hence further investigations into the instrument's provenance are pending. In the end, the sum of the observations so far conducted yields neither evidence for nor evidence against the claimed age of the instrument. Further research into the phenomenon of forgery may also contribute to the final clarification of the instrument's provenance.

[14] The string lengths were compared with each other. Other measurements were used to construct the position of the bridge and sound-hole according to proportions. For this purpose, the pictures were slightly edited and aligned according to the given measurements.

Bibliography

Aibéo, Cristina, Regine-Ricarda Pausewein and Stefan Simon. "Untersuchungsbericht 6_012621, Mandoline (Inv.-No. 5005), Kohlenstoff, Ruß, Aragonit, Oxalat". Unpublished archival material, 29 November 2021. Staatliche Museen zu Berlin, Rathgen-Forschungslabor, Staatliches Institut für Musikforschung, Musikinstrumenten-Museum, MDS ID 6141145.

Becker, Antje, and Heidi von Rüden. "Original, Fake or a Little of Both?" Presentation at the conference "Authentic, Fake or Mistaken Identity?", Ljubljana, ZRC SAZU, 22 October 2021.

Beuting, Micha. "Gutachten zur dendrochronologischen Altersbestimmung einer Pandurinadecke (Inventarnr.: 5005)". Unpublished archival material, 3 October 2021. Berlin, Staatliches Institut für Musikforschung, Musikinstrumenten-Museum, MDS ID 256233.

"Danze". Score. Firenze, Biblioteca del Conservatorio di musica Luigi Cherubini (I-Fc), CF.42. https://opac.rism.info/search?id=850791837&View=rism.

Drögemeyer, Hermann August. *Die Geige: mit eingehender Belehrung* über *den internationalen unlauteren Wettbewerb auf dem Gebiete des Geigenbaues und Geigenhandels*. Berlin: Moritz Warschauer, 1903. https://archive.org/details/diegeige00drge.

Funayama, Nobuko, Nobuko Uchino and Chieko Honma. *Catalogue of the European Musical Instruments of the XVIIth, XVIIIth and XIXth Centuries in the Ueno Gakuen Collection*. Tokyo: Institute for the Study of Musical Instruments, Ueno Gakuen College, 1980.

Heyde, Herbert. *Musikinstrumentenbau: 15.–19. Jahrhundert; Kunst-Handwerk Entwurf*. Leipzig: Deutscher Verlag für Musik, 1986.

Mace, Thomas. "The Second, and Civil Part: or, The Lute Made Easie". In *Musick's Monument*, 32–230. London: T. Ratcliffe & N. Thompson, 1676. https://imslp.org/wiki/Musick%27s_Monument_(Mace%2C_Thomas).

Staatliche Museen zu Berlin PK. "Rathgen-Forschungslabor". Accessed 12 January 2022. https://www.smb.museum/museen-einrichtungen/rathgen-forschungslabor/service/allgemeine-analytische-labormethoden.

IZVIRNIK, PONAREDEK ALI MALO OBOJEGA? VPRAŠANJE AVTENTIČNOSTI PANDURINE GIOVANNIJA SMORSONEJA

Povzetek

Leta 1967 je Muzej glasbil v Berlinu (Musikinstrumenten-Museum) pridobil pandurino, ki jo je v 18. stoletju izdelal rimski glasbilar Giovanni Smorsone. Pandurina (pogosto je imenovana kar mandolina) je izraz za manjše brenkalo s trupom lutnje iz družine mondor. Ima šest črevnatih strun. Resonančna plošča ima zvočno odprtino, prekrito z rozeto, in je bogato likovno okrašena, na primer z lovskimi prizori na ubiralki, kar je značilno za tisti čas. V sonatah, koncertih ali arijah so na pandurini izvajali najvišji glas in je bila primerna zamenjava za violino ali flavto. Pandurina iz Berlinskega muzeja je bila izdelana za plemiško družino iz Firenc, kar je razvidno iz njenega oblikovanja. Danes pandurine hranijo številni muzeji in zbirke po Evropi, v ZDA in Aziji.

Ob priložnosti izposoje tega glasbila s pripadajočo futrolo je bilo izdelano poročilo o njenem stanju in pregledana dokumentacija. Izvor je bil označen kot vprašljiv zaradi odkritih sprememb, ki se ne skladajo z izvirnim stanjem glasbila. Podroben pregled dokumentov je razkril tesno povezavo tega glasbila z družino Werro. Henry Werro je bil leta 1953 obsojen zaradi ponarejanja in poneverjanja.

Nekatere lastnosti obravnavane pandurine nakazujejo, da so nekatere dele prenavljali, na primer mostiček, resonančno ploščo in rozeto v obliki dvoglavega orla. Pod ultravijolično svetlobo so v oranžni barvi videti popravki s šelakom. Slike mikroračunalniške tomografije razkrijejo, da so futrolo že močno naluknjali lesni črvi. Morda so se črvi lotili tudi resonančne plošče in so jo zato obnavljali. V črnem pigmentu so bili odkriti ostanki modernih restavratorskih sredstev, kot je polivinilni acetat, ki se uporablja za lepljenje lesa in drugih materialov. To verjetno pomeni, da so glasbilo obnavljali, še preden je prišlo v berlinsko zbirko. Primerjave z drugimi podobnimi pandurinami so pokazale rahle razlike Smorsonejevega glasbila v Berlinu, v velikosti in obliki in ima tudi dodatno oporo resonančne plošče. Tudi premeri luknjic na mostičku so za tisti čas nenavadno veliki in pod njim je prilepljen košček pergamenta.

Nadaljnje raziskave so dokazale, da ta pandurina ni ponaredek. Na slikah se vidi, da je bil vrat pritrjen z žebljičkom, kot je bilo to običajno. Tudi dendrološke analize resonančne plošče so pokazale, da čas ustreza življenjskemu obdobju Smorsoneja.

Primerjava z drugimi inštrumenti bi lahko razkrila še več, če bi jo opravili na mestu samem in s kritičnimi metodami. Pričakovati je torej še druge analize provenience te pandurine in tudi ponovni pregled dokumentacije o Werrovem ponarejanju bi morda lahko pripomogel h končni razjasnitvi zgodovine berlinske pandurine.