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BETWEEN THE SILENCE OF THE PAST AND THE FUTURE

ABSTRACT

Archaeomusicological research currently conducted at the Institute of Musicology, University of Warsaw, institutionalised thanks to the financial support from the Ministry of Science and Higher Education (grant NPRH), gave the opportunity to develop a wider field of research. The project includes not only the documentation of musical instruments but first and foremost

experimental studies. We started with completely new research on idiophones (*e.g.* on the sounds of lithophones and rattles), returned to previously closed topics (*e.g.* *gusli* from Opole), and developed reconstruction methods using state-of-the-art technology (*e.g.* the reconstruction of flutes).

Keywords: archaeomusicology, idiophones, lithophones, musical instruments, rattles, reconstruction, 3D modelling

The project of archaeomusicological studies at the Institute of Musicology, University of Warsaw (titled *Archaeological Music Instruments in Polish Museum Collections*),¹ was inaugurated by the international conference *Ringling Stones*, held in December 2014 at the Archaeological Museum in Gdańsk on the initiative of the Polish Chapter of The Explorers Club. The conference was dedicated to the current practicalities of the project. Its guests set up a council to discuss the Institute's plans for the commencement of research on the Sudanese lithophones owned by the Museum. The conference not only provided an opportunity to get acquainted with the instruments, whose original context was most likely ritual (as suggested by rock art), but also to discover the extraordinary story of how they were saved from irrevocable loss and brought to Poland.² The participants presented no less impressive counterparts of these 'ringing stones' found throughout Northern Europe: Scotland,³ Norway,⁴ Sweden,⁵ Finland,⁶ and Karelia (in Russia)⁷. A certain similarity of type, form, and sonority, and especially the geographical proximity of the presented

specimens, attracted our students' interest. They announced, half in jest but with genuine zeal, that they were "going to the woods to look for stones".

Looking back on that conference a few years later, we can say that this rather unusual project of 'looking for stones in the woods' has been successfully completed, both literally and figuratively. The topic of lithophones had previously not been discussed in Poland, neither by archaeologists nor by musicologists. Today, however, we get some signals concerning the possible identification of similar instruments.⁸ Most importantly, radically innovative research has been undertaken – previously rare globally and completely absent from Polish musicology and archaeology – concerning the sound of various idiophones, including both huge lithophones and tiny bells or rattles. We have also taken up an earlier avenue of research concerning the possible reconstructions of musical instruments. In our work, we strive to take advantage of most recent technology. Some of it is applied in archaeology, but it has to be modified to match the specific character of musicological research, which gives

¹ The project was financed from the funds of the Ministry of Science and Higher Education as a part of the programme titled *The National Programme for the Development of the Humanities* in 2014–2019. All the conference papers and studies published thanks to this grant bear the following annotation in the bibliography: NPRH project no. 11H 13 0382 82.

² Paner 2014.

³ Purser 2014.

⁴ Kolltveit 2014.

⁵ Lund 2014.

⁶ Rainio 2014.

⁷ Ablova 2014.

⁸ Rudawska 2016a.

our studies a pioneering character. Our new methods of reconstruction also concern historical artefacts that have been preserved only partially or fragmentarily, *i.e.* those deemed useless for research and unimpressive as objects for exhibition and as such previously confined to museum storerooms.

I originally discussed the subject of the research project covered by this grant in my research manifesto titled *Perspektywy polskich badań archeomuzykologicznych* [*The Perspectives of Polish Archaeomusicological Studies*], published in *Polski Rocznik Muzykologiczny* in 2012. In that paper, I predicted the dynamic development of Polish archaeomusicology on the basis of an analysis of relics in Polish museums – despite their humble and relatively undiversified resources. I do still abide by the opinion I then expressed that the scarcity of artefacts “probably makes our situation closer to that of Scandinavian scholars, who greet every newly-unearthed 10th- or 11th-century artefact, no matter how small, with great satisfaction, rather than to the heirs of Pompeii”.⁹ All the same, I must admit that I underestimated our collection with regard to the amount of artefacts available, the diversity of their variants, and the wealth of possible research topics. The already initiated research confirms that “archaeomusicology has a chance to make effective though experimental use of the most recent technologies (different for each object)”.¹⁰ We do not hope for all our experiments to prove successful. We treat our attempts as a rich set of opportunities to look for new research tools and methods as well as a field in which new questions can be posed.

Directions of research

The experiences of three years’ work of our rather little team prove that musicology need not play a merely auxiliary role toward archaeology (for instance by helping to identify artefacts or to reconstruct them). By presenting archaeology with new tasks and formulating previously unasked questions, archaeomusicology – with an emphasis on the *logos* aspect with regard to music – is in fact a partner discipline for archaeology. The conference on lithophones¹¹ which I mentioned above inspired the archaeological circles to ‘hearken’ to the sound of the cave and cavern interiors, to underground rock art,¹²

but also helped popularise the subject of lithophones and attracted attention to these objects in the archaeological circles. Notably, the programme of the conference *Music in Archaeology*,¹³ which summed up the first year of our team’s work and provided an opportunity for a meeting of archaeologists and musicologists, included a discussion on lithophones based on ethno-historical materials.¹⁴

Another example of the inspirational role of our research in the work of archaeologists was the request to prepare sound material for an archaeological exhibition made after we recorded the sounds of the bells at the State Archaeological Museum in Warsaw. The exhibits that we brought to life in this way can be heard at the exhibition *Yatwings – The Forgotten Warriors*.¹⁵

Importantly, our research sometimes calls for interdisciplinary work. It supplies representatives of other academic disciplines with non-standard, original material for their own research, thus assisting these disciplines in extending their field of research. One example of such an interdisciplinary project may be the reconstruction of a musical instrument carried out jointly by a musicology student¹⁶ and a doctoral student of architecture¹⁷ using scans and three-dimensional modelling.

Altogether three main general themes emerge from the documentation work and studies performed to date. These three themes may determine future research directions or at least open up a space for new experiences and experiments. They are: 1) the study of sound, 2) the problems of musical instruments (and sound tools) identification, and 3) the reconstructions of instruments.

Sound and sound tools in space

To an archaeologist, a musical instrument (or, more generally, a sound tool) is usually just one of many finds whose interest lies in their form, ornaments, the context they are found in, or the material and technology used to produce them. At the same time, however, these artefacts used to be (and some of them still are) sound-producing objects. This was the purpose for which they were created in the first place, and, therefore, their sonic qualities are of primary importance: they are always intentional, designed, never accidental. They provide us with knowledge of how people heard the world and about human

⁹ Gruszczyńska-Ziółkowska 2012, 36.

¹⁰ Gruszczyńska-Ziółkowska 2012, 42.

¹¹ The conference *Ringling Stones*, Archaeological Museum in Gdańsk, 12–15 December 2014.

¹² Zymczak 2014.

¹³ Institute of Musicology, Warsaw, 4–5 March 2016. NPRH project no. 11H 13 0382 82.

¹⁴ Tunia 2016.

¹⁵ The exhibition opened in September 2015 in Jeleniewo and was later moved to Elk and Warsaw. Since February 2016 it has travelled through Norway and then Poland.

¹⁶ Gruda 2016.

¹⁷ Marta Pakowska, MEng, doctoral student supervised by Prof. dr hab. Jacek Kościuk at the Laboratory of 3D Scanning and Modelling at the Institute of Architecture, Wrocław University of Science and Technology.

contributions to the soundscape – an element that frequently escapes us nowadays, in an age dominated by noise and the surrounding acoustic chaos.

And yet, the world around us is by and large an orderly one, and it also has its sonic order. Some elements of this order are cyclical, regular, or permanent and can therefore impart to us information concerning, *e.g.*, a time of day (night, morning), a place (a meadow, a street), or some special situations (the sound of a thunder or of an alarm). The acoustic landscape, basically invariable in itself, is internally diversified, and humans modify it even further, customising and individualising it to suit their purposes.¹⁸

Lithophones

The natural, and at the same time unique, qualities of some spaces (such as *e.g.* caverns) not only facilitate new experiences but in fact also provoke people to experiment with sound. On the other hand, there are objects around us whose acoustic qualities make us intuitively use them as musical instruments. These include large stones or rocks that possess specific acoustic qualities and have, therefore, been used to produce sounds. It is worthwhile to take a closer look at these objects and even to conduct research into them as one of the oldest known types of musical instruments.¹⁹

Several such instruments, found in Sudan, were rescued by a team of archaeologists from the Archaeological Museum in Gdańsk (the rocks were being flooded at the bottom of a water reservoir as a result of the

construction of a dam on the Nile) and are today recognised, along with numerous rock carvings, as a unique collection of finds (Fig. 1).²⁰ In recent years, such Sudanese lithophones, originally accompanied in their place of discovery by rock art, became famous in archaeomusicological circles mainly owing to the research carried out by Cornelia Kleinitz, who identified nearly a hundred such instruments and documented many of them by describing their locations, making sketches, and taking photographs as well as creating several short films, which also comprise some basic record of the instruments' sounds. However, as an archaeologist, Kleinitz dedicated little attention to the sound qualities of those objects. She studied their spatial arrangement and the interesting location of the individual finds in the territory under study, as well as their appearance in groups, which she even termed 'soundscapes', referring to the sonic use of lithophones as 'rock music'.²¹ There are many examples of such lithophones in the world's literature on the subject. It needs to be emphasised that – though our knowledge about 'ringing stones' is mainly based on ethnographic sources and, to a lesser extent, on historical records – they are usually considered a long-standing, stable, and regular component of local cultures.²² The most frequently discussed aspects of these instruments include their ritual and communicative functions. In her survey of African publications dedicated to lithophones, Natalia Arciszewska pointed out to the rarely-observed fact that, apart from using the instruments merely to send signals, some specific qualities of speech could be imitated by representing the tonal structures of words and prosody



Fig. 1. Big lithophone from Sudan (no. 164 p, Archaeological Museum in Gdańsk, 2014) – registration of sounds (photo by P. Ziółkowski).

¹⁸ The question has been discussed widely also by Renáta Beličová (2014).

¹⁹ Fang 2010; Lawson 2014.

²⁰ Paner 2014.

²¹ Kleinitz 2014.

²² Arciszewska 2016.

on those instruments, which would place lithophones on the same level as the so-called talking drums.²³

Many phenomena directly related to musical issues were discussed during the *Ringling Stones* conference, especially in those papers that were devoted to Northern European lithophones.²⁴ John Purser, who presented both photographs and sound recordings, pointed out the great diversity of form and acoustic effects produced by Scottish idiophones as well as the resulting folk interpretations of these sounds. Riitta Rainio analysed the structure of a series of sounds of a single lithophone from Finland. An important point in the debate that summed up the conference was Jan Žera's statement, combined with a brief presentation, in which he demonstrated that a lithophone is basically a resonating slab. Its acoustic qualities depend on the places in which nodes appear, as well as the shape in which its base is formed (a cavity, some kind of 'feet' or other type of structure that mutes the sound) and the direct surroundings: another stone or a niche in the rock in which the lithophone stands, the way it is separated from the sandy ground, and the ways in which good resonance is guaranteed. These aspects of lithophones gave rise to more questions and opened up new areas of study (though not necessarily for musicologists themselves), since, according to the archaeologists, the lithophones brought by them to Poland had not been processed in any way, and, therefore, both their shapes and positions ought to be considered natural. The huge number of larger and smaller lithophones in the area of the Fourth Cataract of the Nile calls for a systematic study of their forms and acoustic contexts. Unfortunately,

most of this material has been lost. The more important, it seems, is the study of the material that remains available to us, complemented by the sizeable photographic archive of the Sudan team at the Archaeological Museum in Gdańsk.

One of the most interesting questions is one concerning the original location of the largest of the lithophones transported to Poland. Photographic documentation proves that it lay on a stone of a different kind (or at least a different colour) but of an astoundingly similar shape. Judging by the large number of marks left by hitting the lithophone, as well as by the depth of some of these cavities, which suggests frequent or prolonged use of the instrument, this stone most likely had good acoustic qualities. It is temporarily kept in the museum storeroom, in conditions unfavourable to bringing out its acoustic qualities. Hopefully, further research may establish the optimum conditions for exhibiting this valuable find.

An analysis of the sound of two Sudanese lithophones, recorded in Gdańsk by a group of students from the Institute of Musicology, University of Warsaw, reveals a surprisingly poor sound quality of the larger instrument (muffled, heavy, not sonorous). This could be caused by the loss of the stone's original context/ placement: now it lies flat on a wooden pallet, while in Sudan it was situated on another rock, and its points of support were a bit different (Fig. 1). The smaller of the two lithophones is more promising as an object of study. Detailed observation of the sounds forming in four points in the proximity of the stone confirmed the prediction that, despite the different impressions of the sounds produced by hitting the stone

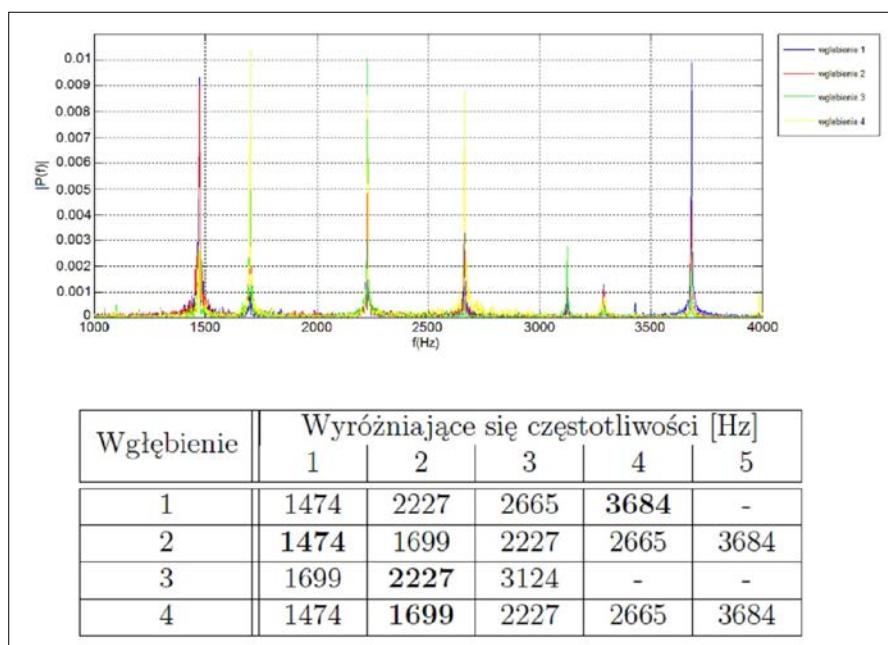


Fig. 2. Small lithophone (Archaeological Museum in Gdańsk) – sounds of four 'cup-marks'. An analysis by M. Misiurewicz (Misiurewicz 2017) shows that the difference of the sounds is, in fact, an impression created by a different exposition (volume) of various harmonics of the same sound.

²³ Arciszewska 2015.

²⁴ Koltveit 2014; Purser 2014; Rainio 2014.

at different points, they are in fact all of the same pitch and differ only in the exposition (volume) of their various harmonics (Fig. 2).²⁵ Such study constitutes an important and innovative contribution to the systematic research into lithophones. Their presence in various cultures has been noted for a long time, and their sounds have been recorded, but acoustic studies are still in the initial phase.

As mentioned above, already after the inauguration of our project, we received signals concerning the possible presence of lithophones also in Poland. Knowledge about the location of stones that possess unique qualities – symbolic and in many cases also acoustic – has for a long time been preserved in local traditions, as demonstrated by Krzysztof Tunia on the basis of abundant ethno-historical material.²⁶ Some of the hypothetical lithophones can still be localised, but unfortunately they are not always found in their original forms. Anna Rudawska, who saw the famous two-element ‘clicking stone’ (locally known as Klickstein) from near Rościno (formerly Rostin in Hinterpommern) – or rather what is left of it after one of the parts was taken off and moved many kilometres away to serve a new function – learnt from local tales that the smaller stone placed on the bigger one produced a clicking-knocking noise whenever a person ‘with a guilty conscience’ was passing by.²⁷

Rattles

Since the initial planning phase of our project, it has been our intention to make sound recordings of ceramic rattles from museum collections (Fig. 3). This was mainly to serve documentation purposes, though sound analyses were also considered a possible option, mostly for the sake of scholarly diligence. It has turned out, however, that the sound material of the rattles is so varied and diversified that it deserves a separate in-depth study. The topic was taken up by Katarzyna Tatoń, an archaeologist who already had some experience with idiophones from the time of her work on the book titled *Archeologia muzyki: starożytny Egipt* [*The Archaeology of Music: Ancient Egypt*], dedicated to Egyptian archaeological musical instruments in Polish collections.²⁸

At present, we have recordings of c. 240 objects (belonging to different collections) at our disposal. However, as demonstrated by the results of previous research, the number of still sounding rattles should be estimated at several hundred. The set of artefacts also includes other objects that have been damaged or only fragmentarily preserved. These constitute excellent supplementary material which provides additional information concerning



Fig. 3. Clay rattle from Brzezic (no. 28gr69_86, Museum of the Kalisz Land, Kalisz, 2016) (photo by K. Tatoń).

such acoustically significant qualities as the shape of internal structure as well as the kinds and number of movable components.

Our initial ‘rattling’ explorations have brought many surprises and shown that, as a rule, there is no direct link between the form and the type of sound or its volume. This is also true of instruments that look alike and represent the same culture or similar dating and locations. The relation between size and sound is frequently a source of surprises. Relatively large objects can prove quiet and ‘rustling’, while quite loud and distinct rattling sounds can be produced by small instruments. This results not only from the type of ‘peas’ placed inside but also from the shape of the sound chamber (internal construction) and the type of ceramics involved.

Rattle tones are in general of a high register, and their harmonics very frequently exceed the human hearing range (Fig. 4). Their functions seem to have been rather different from the typical functions of musical instruments. They are mostly found in graves and are a kind of ‘bridge’ between two types of objects: they must be viewed as sound tools, but they also sometimes resemble other, purely ritual items (e.g. the painted ‘eggs’: rattles and not rattles of clay or stone frequently found in graves from the 10th to the 13th century)²⁹.

²⁵ Mazgaj 2016, 1–9; Misiurewicz 2017, 1–9.

²⁶ Tunia 2016.

²⁷ Rudawska 2016a.

²⁸ Tatoń 2013.

²⁹ Dymek no date.

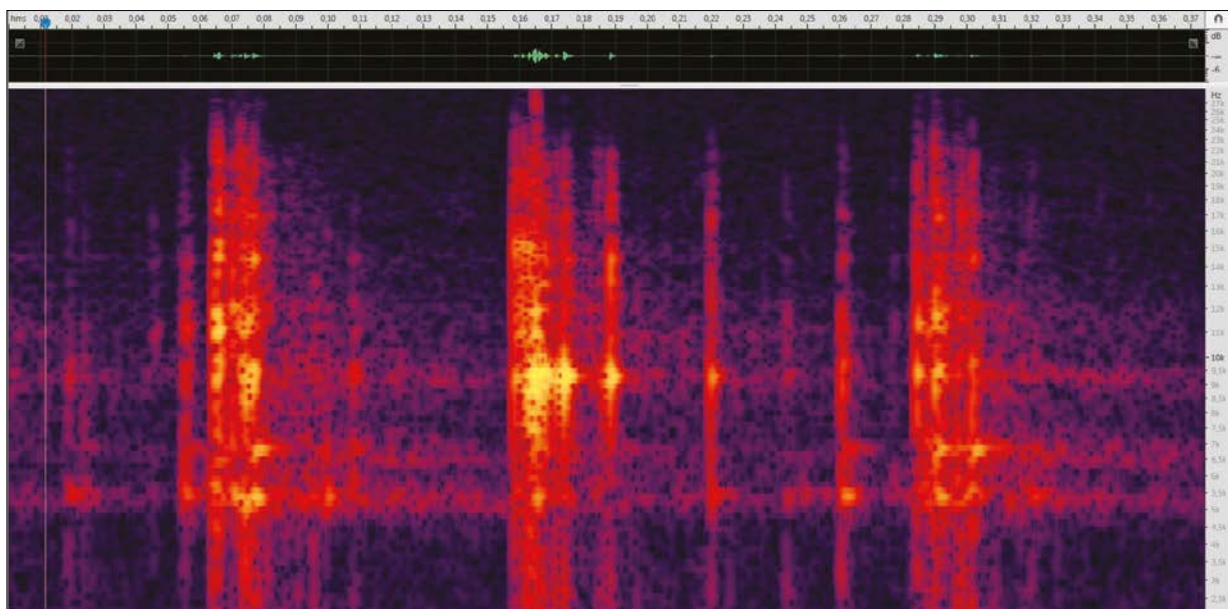


Fig. 4. Clay rattle from Brzezie (no. 28gr69_86, Museum of the Kalisz Land, Kalisz, 2016). Spectrogram shows the formant frequencies (c. 5 kHz, 6.5 kHz, and specially marked – c. 9.5 kHz) and the quite clear exposition of the high frequencies (up to c. 26 Hz), exceeding the human hearing range (registration of the sound by K. Tatoń, 2016; analysis by A. Gruszczyńska-Ziółkowska).

Clay rattles have attracted the interest of archaeologists for a long time. Comprehensive work on their classification, studies concerning the range of occurrence of their various types, and ways of disseminating some models have been conducted. Detailed analyses have also addressed the very material they were made of, including glazing techniques and types of glazes. An interesting image of the archaeologists' comprehensive studies of rattles emerged from our conference *Muzyka w archeologii [Music in Archaeology]*.³⁰ All in all, we could say that the only topic that is missing from archaeological research is the sound – which is a small and a great deficiency at the same time.

Bells

Like rattles, also bells produce interesting acoustic phenomena in the ultrasound range,³¹ and, like the former, they have not been subjected to systematic research in Poland.³² Most collections include meagre assemblages or even only individual specimens. The State Archaeological Museum in Warsaw³³ is one of the few institutions in the country to boast a large collection of

bells, several dozens of which are in good condition and can still produce sound. They are objects of varying provenience, mostly from north-eastern Poland, including Yotvingian bells from the area of Szurpiły and Szypliszki, as well as a beautiful set of bells and clashing metal plates, of varied forms and shapes, which Zygmunt Gloger collected late in the 19th century during his field studies in Polish Livonia – in the boroughs of Rzeżyca (Latvian: Rēzekne) and Lucyn (Latvian: Ludza, both now in Latvia) among others. Gloger called these bells *brząkadła* ('jingles'). They were attached to horse harnesses or constituted a part of necklaces, clasps, belts, and other elements of a garment.

Archaeologists have painted such a suggestive image of the application of bells³⁴ that it became the topic of two interesting sound impressions. One is the already mentioned composition accompanying the exhibition *Yatvings – The Forgotten Warriors* (PMA 2015), whose main idea was to present sound as a museum exhibit. The task was by no means easy, since the sounds of the individual bells are quiet and hardly distinguishable. The four persons who carried out this project were

³⁰ Kalaga 2016; Siemianowska 2016.

³¹ Jankowski 2016, 1–10, plus sound recordings.

³² Such research is rare also worldwide. One original study of a similar class of artefacts is the doctoral dissertation of Riitta Rainio of the University of Helsinki (Rainio 2010).

³³ Department of Archaeology of the Baltic Peoples, State Archaeological Museum in Warsaw.

³⁴ E.g. Jończyk 2016.

each to produce a three-part music piece consisting of any sequence and rhythmic arrangement of individual sounds of bells (part I), original sounds in any combination, for instance polyphonic (part II), and original bell sounds used as part of a composition also involving other sounds (part III). A 6-minute-long multimovement piece was formed out of this material, whose interlaced but clearly distinguishable sections are built out of original and newly-composed sounds. Every person visiting the exhibition can familiarise themselves with the artefacts' most important quality – their sounds. On the other hand, thanks to the concept of thematic composition, these genuine sounds are not 'petrified', feeble, and monotonous, but – on the contrary – they enliven and animate the museum space along with the sound of rustling forest trees, rain, and thunderstorm, as well as mounted troops.³⁵

The other application of the documentary material (interesting also for the museum staff) is the reconstruction of space with ringing bells created by Justyna Kotarska, who 'embedded' the original bell sounds in an imaginary space. Based on the suggestions of archaeologists, and taking into account the original placement and functions of the bells, she created four sound simulations titled: "Winter Space", "Footfalls in the Snow", "Bells as Pieces of Jewellery", and "A Bundle of Bells".³⁶

Identification of musical instruments

Identification – and later reconstruction – of instruments constitutes a separate group of research problems. Our studies involve two stages of identification. In the first, we aim to determine whether a given relic is a sound tool (or its fragment) at all. This stage is an excellent field for collaborations between archaeologists and musicologists. For this reason, separating the potentially 'sound-producing objects' from among various not easily identifiable artefacts seems fully justifiable, though even

for musicologists such objects are sometimes a genuine puzzle. The preserved finds are for the most part popular, commonly used instruments, whose models can be found in ethnographic material. The so-called professional musical instruments are rare and come from relatively recent historical past. Due to the disappearance of certain instrument building technologies or materials in some regions, in other words – the discontinuity of traditions related to instrument construction – parallels from other areas can also prove useful. The decision to classify a given object as a sound tool has not been taken yet with reference to some artefacts which demand further in-depth comparative studies.

Contrary to what may seem, identification of sound tools is not easy, and even experienced researchers risk over-interpreting or underestimating a given find.³⁷ Problems with classification may result from the fact that in some circumstances any object may become a sound tool. For instance, a wooden or bone pipe will produce sound if one blows into it properly – which need not mean that this was in fact its original application. In some cases, it helps to consult wider material, which makes it possible to study various alternative solutions,³⁸ while in others (where the object is ambiguous with regard to application) – we must leave room for doubt.

In the second stage, we recognise the model of the instrument, define its pattern, and analyse those details of its construction which support the interpretation we have presented. The task of fully identifying the instrument and pointing to a specific design pattern is particularly difficult with reference to heavily-damaged or only fragmentarily preserved objects. In such cases, the identification process involves not only a detailed analysis but also a search for comparative material (other artefacts, iconography), as well as planning and reconstruction work that takes into account various possible structural solutions. In the course of this process we discover more and more details and ask new questions. What results is

³⁵ Concept of the composition: Anna Gruszczyńska-Ziółkowska; composers: Joanna Dubrawska-Stepniowska, Adam Jankowski, Andrzej Stepniowski, Przemysław Ziółkowski (morenoise.eu); mixing and mastering: morenoise.eu.

³⁶ Kotarska 2016.

³⁷ One of the world-famous collections published a catalogue of finds which classifies ceramic vessels belonging to one culture according to their forms. Though it was noticed that one of the items had a hole drilled in the pot's bottom, this observation did not influence its classification and (in a way) interpretation as a piece of kitchenware, while in fact it was a vessel drum – a type of kettledrum – in fact typical of that culture. This little hole in the bottom ought to have been recognised as unmistakable evidence of the object being a drum. In instruments with

closed bodies, such holes serve as valves for the air compressed by hitting the membrane. Thanks to the presence of the hole, the membrane can vibrate freely, since the air is both pressed out and sucked in through the hole. The movement of the membrane is thus not abruptly suppressed or stopped.

³⁸ The identification of bone tubes with two holes placed transversely close to each other as two-note whistles probably needs to be revised. According to Andrzej Piotrowski of the State Archaeological Museum in Warsaw, this interpretation (accepted by authorities in the field of musicology and found in the literature) may be the result of a mistake and over-interpretation, since it disregards rather numerous Russian finds which point to the use of such tubes as tools for spinning thread (A. Piotrowski, personal communication).

a kind of interpretation of the find – of its proposed form and, indirectly, also of the musical practice involved.

Reconstructions

The umbrella term ‘musical instrument reconstruction’ is not used very precisely nowadays. It is applied to various types of actions undertaken with different results in mind. We should in fact talk about three types of reconstruction. The first is restoring an instrument using original materials (for instance by putting together a fragmented object). Archaeologists carry out many such ‘re-constructions’, for instance of ceramic rattles. The missing elements are frequently filled in so that the artefact can be presented in its complete form. This is usually done at the expense of the loss not only of the acoustic qualities (which were already impaired by the damage) but also of information about them. Broken rattles play a major role in research because they reveal how the most important part of the instrument – the interior of its acoustic chamber – was formed. The rattling ‘peas’ are also exposed. The same is true for other instruments.

The second type of reconstruction is related to performance practice. It depends first and foremost on the thorough examination of the object (measuring its dimensions, identifying materials, *etc.*). Subsequently, a kind of a copy of the instrument is built using historical (or at least ‘archaicising’) technologies. Since most of the finds are damaged and largely incomplete, their forms must be restored. In the last stage, the thus constructed instruments are made to produce sound – which is to a great extent a question of interpretation (*e.g.* the type of blast on aerophones, the choice of strings, tuning, and playing technique on chordophones, *etc.*).³⁹ This type of reconstruction has the advantage of obtaining an instrument that produces ‘live’ sound. The main disadvantage is the relatively wide range of interpretation, which means that research work in the strict sense of the term ends at this point.

Our team has conducted reconstructions of the third type, which aim, among others, to study the construction of a find so as to collect the greatest possible amount of data concerning the key ideas underlying

an instrument’s construction, as well as to test research methods and the possible scope of applications for new technologies. This concerns the type of work where the stage of experiments with the original objects is limited and replaced with modelling.⁴⁰ In such research, reconstructions are virtual, and the object is modelled on the basis of three-dimensional scans. As a rule, the image of a model proves sufficient for the reconstruction of instruments’ forms. Various solutions are tested and verified on a virtual model. However, we also create 3D prints, which make empirical studies of the details of a construction to some extent possible.

We have undertaken a study of four very different finds. Two of these are the well-known *gusle* (Pol. *gęśle*) of Opole, also quoted by foreign researchers (two lyres from Ostrówek in Opole, 10th–11th century).⁴¹ The other two are fragments (central parts) of aerophones – a bone pipe from Człuchów (mid-15th–16th century)⁴² – and a wooden Baroque flute from Wrocław (early 18th century).⁴³

Our study of the two-string instruments is to verify the previous reconstructions and interpretations. We use the basic archaeological data as our point of departure. Our work, therefore, focuses on meticulous examination of the finds and the study of their original contexts. The study, undertaken by Anna Rudawska for her MA thesis, is still in progress,⁴⁴ but we can already say that the emergent questions include the choice of material for the strings, the way the strings were attached, and the technique of playing. Iconography⁴⁵ plays a major role in this research, as do comparative studies focusing mostly on lyres found in Northern Europe (Scandinavia, England, and a find from Gdańsk in Poland) and in the north-east of the continent (Veliky Novgorod).

The study of the bone pipe aims at the best possible reconstruction of its both ends, as well as experiments with sound production using this pipe and determining its type. The study will result in creating a copy/reconstruction of the object, thus making reasonably good quality sound production possible. This is meticulous research which required participation of an archaeozoologist who helped identify the animal (goose) whose bone had been used and choose one of the many biologically possible and justified models.⁴⁶ Modelling is based on precise 3D images of both the pipe⁴⁷ and the bone

³⁹ Mazurek 2016.

⁴⁰ Such studies are still rare. Examples include the bridge from Pasture Cave (Purser, Lawson 2012) and Maya finds (Katz 2016).

⁴¹ In the collection of the Institute of Archaeology and Ethnology, Polish Academy of Sciences in Wrocław (Bukowska-Gedigowa, Gediga 1986; Rudawska 2016b).

⁴² In the collection of the Institute of Archaeology, University of Warsaw (Starski 2016).

⁴³ In the collection of the Archaeological Museum – Branch of the City Museum of Wrocław.

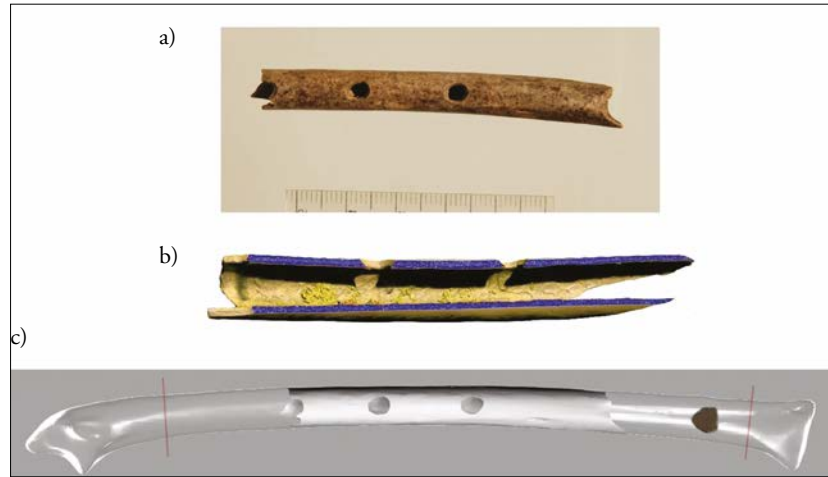
⁴⁴ Rudawska 2016b.

⁴⁵ Kubies 2016, 1–13.

⁴⁶ Anna Gręzak, Institute of Archaeology, University of Warsaw.

⁴⁷ Tomography performed at the Chair of Geotechnics, Hydraulic Engineering, Underground and Hydraulic Structures, Department of Civil and Hydraulic Engineering, Wrocław

Fig. 5. Bone pipe from Człuchów (no. Cz.Z.19-B, Institute of Archaeology, University of Warsaw). a. Original view (photo by M. Dąbski) and two phases of the process of 3D reconstruction; b. Tomography (M. Rajczakowska); c. Example of virtual modelling (M. Pakowska) according to the identification of the bone's type by Dr A. Gręzak.



used as our model (Fig. 5). Though this research concerns a simple pipe, analogous procedures can be applied in the future to instruments of a more complex built.⁴⁸

Work on the preserved fragment of the Baroque flute from Wrocław was also an interesting experience. This find was the topic of a BA thesis by Aleksandra Gruda, who carried out historical research into the development of the flute in the period of the find's dating, taking advantage, among others, of a study of the flute iconography.⁴⁹ At this stage, Gruda's work aimed to discover a suitable model, which proved rather difficult, since many different manufactures were active at that time, and their products sometimes differed significantly from one another. As a result of the study, which used detailed design drawings of the flutes, two possible models were established: those by T. Lot and J.-H. Rottenburgh. 3D modelling constituted a separate stage of the study. The find was scanned in detail, the scanned surfaces were put together and cleaned of any defects. The design drawings of flutes by Lot and Rottenburgh (made by Jean-François Beaudin) were entered into AutoCad, turned into vector graphics using this software, and then sent to the Rhinoceros 5.0 program,⁵⁰ which converted them into solids of revolution.⁵¹ Two thus obtained virtual sets of flutes were compared with the archaeological find. It turned out that fitting the find into Rottenburgh's set created a gap *c.* 3 mm wide between the model and the head joint of the find. The Lot model was therefore

eventually selected as better fitting.⁵² A 3D print of the flute was also made.

It was not our aim to physically reconstruct the instrument complete with all its acoustic qualities. This would have been costly and quite unnecessary, since the so-called Baroque flutes, built in accordance with historical designs, are common in today's performance practice. Similarly as in the case of the above discussed pipe, our aim was to test an innovative method of reconstruction. The obtained 3D print can, however, prove useful in museum practice.

Education

One of the aims of the project was to educate young researchers. This was one of the requirements of our patron and of the National Programme for the Development of the Humanities, which provided funds for the project. Over the two-year period of research, about twenty students collaborated with our archaeomusicological studio to a greater or lesser extent, and they represented all three levels of studies at the institute: BA, MA, and PhD courses. Three of these students represented disciplines other than musicology.⁵³ One MA thesis, one BA thesis, and one engineering diploma work have been completed;⁵⁴ three MA theses and one doctoral dissertation are in progress. All these theses are based on

University of Science and Technology, under the supervision of Prof. Dariusz Łydźba.

⁴⁸ Modelling preparation: Marta Pakowska (3D Scanning and Modelling Laboratory, Faculty of Architecture, Wrocław University of Technology, under the supervision of Professor Jacek Kościuk). Pakowska 2016, 1–5.

⁴⁹ Winiarska 2016, 1–22.

⁵⁰ Pakowska 2016.

⁵¹ Pakowska 2016.

⁵² Gruda 2016, 1–51.

⁵³ History of art, acoustics, and architecture.

⁵⁴ Gruda 2016, 1–51; Gawarska 2017, 1–124; Adamczyk 2018, 1–79.

the material collected as a result of our research and make use of state-of-the-art research technology. Admittedly, without the funding these theses and dissertation would not have been possible.

The young grant beneficiaries also took part in two international archaeomusicological conferences co-organised by the Institute of Musicology of the University of Warsaw. The first of these was *Ringling Stones*, held at the Archaeological Museum in Gdańsk in December 2014, in which 6 students took part. Among their tasks was to carry out methodical recordings of lithophone sounds, which were to constitute the basic analytic material, as well as to compose 'music impressions for lithophone' for the needs of a museum broadcast for children. Our second meeting, the 14th ICTM Study Group on Music Archaeology, was held at the Archaeological Museum in Biskupin in August 2015 (five participants). Both conferences were organised at the early stage of research work, which means that the students did not present their results there but used the opportunity to become acquainted with most recent results of archaeomusicological studies, as well as to take part in numerous conversations and debates. But at the next Conference of the ICTM Study Group on Music Archaeology, in Ljubljana (Slovenia, 2017), the reconstruction of the Wrocław flute was presented by Aleksandra Gruda and Marta Pakowska.⁵⁵

Already in March 2016, twelve researchers took active part in the conference *Music in Archaeology*, which was financed from the grant and summed up the first year of our work. All the participants delivered papers or presented brief reports on their research or auxiliary activities (such as the overview and classification of material, sound recordings, etc.). Though this meeting was

conceived as a working session, it attracted numerous persons from outside the group of the grant beneficiaries, mainly archaeologists.⁵⁶ It is necessary to emphasise the presence of the participants of the project at two Organological National Conferences in Ostromecko,⁵⁷ where they delivered four papers in 2017 and eight presentations in 2018.

Of note was the participation of one of our students – Natalia Arciszewska – in the 22nd *All-Polish Research and Education Nubiological Conference* (Gdańsk-Sobieszewo, May 2015), where she discussed our studies on the Sudanese lithophones in her paper titled *Analogie dla litofonów sudańskich: typy i konteksty występowania w Nigerii* [*Analogies to Sudanese Lithophones. Types and Contexts of their Occurrences in Nigeria*], which was greeted by the archaeologists with great interest.

Conclusions

In the context of the future of Polish archaeomusicology, we will certainly need to discuss issues of documentation and its use. The scope and type of documentation we create is determined by the research programmes and tasks that we implement. Our work did not aim to create a database of all the relevant museum finds, which means that our documentation is limited to those artefacts that we select for our studies. However, the scope of these studies is now already quite wide and certainly untypical, since they also involve sound material. The latter is systematically classified and made accessible to the owners of the finds, who can use it to update and modernise their catalogue records (which can include sounds and instrumental settings), as well as during exhibitions and lessons in the museums.

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⁵⁵ Gruda, Pakowska 2017.

⁵⁶ Both the conference and the team's independent work attracted media interest. PAP agency printed a note (ed. Szymon Zdziębowski – *News: Nauka w Polsce* [*Science in Poland*], <http://naukawpolsce.pap.pl/aktualnosci/news,408678,archoemuzykologia--poczatek-nowej-dyscypliny-naukowej-w-polsce.html>, accessed 20.03.2017), and PR24 broadcast a radio programme (ed. Katarzyna Kobylecka, *Czas na Naukę* [*Time for Science*], <http://www.polskieradio.pl/130/4430/Arty->

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⁵⁷ Organised by the Institute of Musicology of the University of Wrocław, the Municipal Cultural Centre in Bydgoszcz, and the Faculty of Instrumental Music of the Feliks Nowowiejski Music Academy in Bydgoszcz (<http://mck-bydgoszcz.pl/?p=wyzdarzenia&id=7452>, accessed 02.12.2018; <http://konferencja.instrumenty.edu.pl/2018/08/20/program-ii-ogolnopolskiej-konferencji-instrumentologicznej/>, accessed 02.12.2018).

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