

PELLET BELLS AND BELLS FROM THE AVAR PERIOD IN THE HUNGARIAN NATIONAL MUSEUM

AVAR KORI CSÖRGŐK ÉS CSENGŐK A MAGYAR NEMZETI MÚZEUMBAN •

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Abstract

The Great Migration Period collection of the Hungarian National Museum houses more than 67 pellet bells and bells from the Avar Period, which are part of the research project 'Metallic Idiophones between 800 BC and 800 AD in Central Europe'. They originate from 17 archaeological sites. The idiophones are presented within their find context and classified into types. Chemical analyses were carried out non-destructively by using a handheld XRF. The sounds of the original objects were recorded and analysed about their frequency ranges and psychoacoustic parameters. Several suggestions of the idiophones function complete the article. Ten textiles were analysed on the pellet bells, revealing some information on possible pieces of clothing and the positioning in the burial.

Kivonat

A Magyar Nemzeti Múzeum népvándorlás kori gyűjteményében tizenhét lelőhelyről származó, több mint hatvanhét, avar kori csörgő és csengő található, amelyeket a 'Metallic Idiophones between 800 BC and 800 AD in Central Europe' kutatási projekt keretében vizsgáltunk. Bemutatjuk a tárgyak leletösszefüggéseit és osztályozzuk őket. Kémiai összetételüket roncsolásmentesen, kézi XRF spektrométerrel határoztuk meg. Rögzítettük a tárgyak hangját, elemeztük a frekvenciatartományukat és pszichoakusztikus paramétereiket. Az idiofonok funkciója kapcsán több elméletet felvázolunk. Tíz, csörgőn megőrződött textilmaradványt is elemeztünk, amely révén adatot kaphatunk a lehetséges ruhadarabokról és a síron belüli elhelyezkedésről.

KEYWORDS: BELLS, PELLET BELLS, AVAR PERIOD, ARCHAEMUSICOLOGY, ACOUSTIC, PSYCHOACOUSTIC, ARCHAOMETRY, TEXTILES

KULCSSZAVAK: CSENGŐK, CSÖRGŐK, AVAR KOR, ARCHEOMUZIKOLÓGIA, AKUSZTIKA, PSZICHOAKUSZTIKA, ARCHEOMETRIA, TEXTILEK

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Introduction

Whereas bells are known from the Early Avar Period (EAP), pellet bells appeared at the transition of the Middle Avar Period (MAP) I to II (Csuthy 2019; Pomberger & Stadler 2018a). Which role did bells and pellet bells play in the Avar people community? What was their sound and acoustic influence in daily life like? Which material was used for producing them? The Great Migration Period collection of the Hungarian National Museum houses more than 67 pellet bells and bells from the Avar Period, which are part of the research project mentioned in the next text section. These sound objects stay in the focus of this article. Additionally, we discuss the analysed textiles found on some of the pellet bells with regards to the clothing and objects connected to the idiophones.

The Research project ‘Metallic Idiophones between 800 BC and 800 AD in Central Europe’

The research project ‘*Metallic Idiophones between 800 BC and 800 AD in Central Europe*’ is funded by the Austrian Science Fund (Hertha Firnberg) and supported by the Natural History Museum Vienna, Austria. The goal of the project is to investigate bells, pellet bells and costume jewellery with jingles originating from the Iron Age, the Roman Empire and the Early Middle Ages. The metallic sound objects are studied with an interdisciplinary approach. Indications of the possible function of the idiophones (bells) may be garnered via archaeological methods, and additionally, the find position can be compared with statements in written ancient sources. Chemical analyses show up the different alloy components, which influence the tonal appearance. Acoustic and psychoacoustic analyses explore the pitches and characteristics of sounds. Sound recordings of each object — as long as it is playable without being damaged — are carried out in a transportable insulated recording chamber (Pomberger & Mühlhans 2022). The attempt to study the influence and functionality of sounds in archaeology with (psycho-) acoustic measurements is a novelty and provides interesting new insights. In order to retrace the individual steps in the production of the metallic idiophones, we use the methods of experimental archaeology. And since there are traces of textiles adhering to bells, they are investigated and might be an indication to their possible original function as sounding components of human clothing (Pomberger et al. 2020, 215–242; Pomberger et al. in print_a, Pomberger et al in print_b; Pomberger et al in print_c) (see Fig. 1.).

The sites and the dating

Pellet bells and bells housed in the Avar Period collection of the Hungarian National Museum in Budapest originate from 17 sites. The idiophones of 16 sites will be discussed in this paper and those from Keszthely will follow in a later paper. All bells and pellet bells originate from cemeteries. No bell or pellet bell was found in a settlement.

Three sites are located in Tolna County: Cikó, Gerjen and Regöly-Kapuvár. Two cemeteries are known from Cikó with a total of about 600 graves, dating from the Early Avar Period to the Late Avar Period (LAP). Two Late Avar Period graves contained a bell and a pellet bell (Kiss & Somogyi 1984; Szentpéteri 2002; see cat. 1–2) (App. Fig. 18.). The Late Avar Period cemetery in Gerjen-Váradmajor, Váradpuszta, Várad with a total of 185 burials so far excavated, contained one grave with a pellet bell (Kiss & Somogyi 1984; Szentpéteri 2002, see cat.6) (App. Fig. 18.). Among the 179 graves from the cemetery Regöly-Kapuvár Bozót-dűlő only one grave contained a small bell. The cemetery dates from the first half of the 7th to the 9th century (Kiss & Somogyi 1984; Szentpéteri 2002; see cat.52).

The Halimba-Belátó-domb cemetery, Veszprém County, consists of 489 graves. Eight of them contained pellet bells and bells, in total 15 idiophones. The cemetery dates from the Middle to the Late Avar Period (Török 1998; Szentpéteri 2002, see cat. 7–21) (App. Fig. 20). The cemetery at Jánoshida-Tótkérpuszta contains 256 graves dating from the Middle to the Late Avar Period. Pellet bells were found in only three graves (Erdélyi 1958; Szentpéteri 2002; see cat. 22–24) (App. Fig. 22.). In an unknown grave from the cemetery in Jászsalsószentgyörgy, one pellet bell was unearthed (Madaras 1995; Szentpéteri 2002; see cat. 25) (App. Fig. 18.). Both cemeteries are located in Jász-Nagykun-Szolnok County. 15 tiny gold sheet bells and one pellet bell were excavated in the cemetery of Kiskőrös-Vágóhídi-dűlő, Bács-Kiskun County. They originate from six graves and date to the Late Avar Period (László 1955; Garam 1993; Szentpéteri 2002; see cat. 26–31) (App. Fig. 23.). From the cemeteries in Kölked-Feketekapu A, Baranya County, with about 600 graves in total, five graves belonging to the older cemetery (periods EAP–MAP) contained bells and one grave belonging to the younger cemetery (period LAP) contained a pellet bell (Kiss 1996; Szentpéteri 2002; see cat. 32–39) (App. Fig. 24.). The Szebény cemetery I, Baranya County, consists of 341 graves. In four of them three pellet bells and one bell were found. They date from the periods MAP–LAP (Garam 1975; Szentpéteri 2002; see cat. 55–58) (App. Fig. 27.).

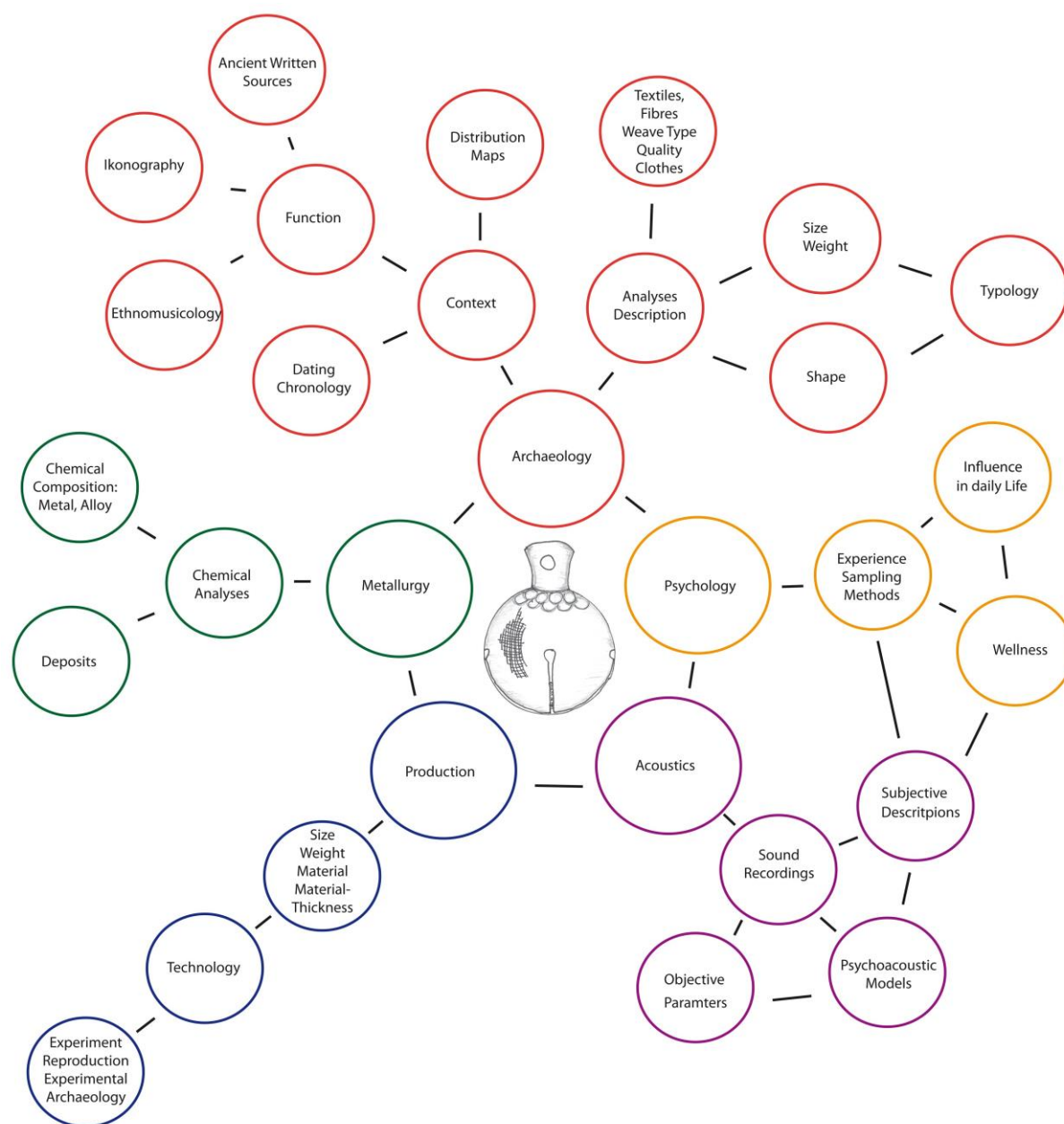


Fig. 1.: Model of the interdisciplinary research project (graphic: B. M. Pomberger).

1. ábra: Az interdiszciplináris kutatási projekt modellje (rajz: B. M. Pomberger)

Only one pellet bell is known from the cemetery in Mosonszentjános-Kavicsbánya, Győr-Moson-Sopron County, also dating to the Late Avar Period (Fettich 1927, Szentpéteri 2002; see cat. 40) (**App. Fig. 18.**). Another Late Avar Period pellet bell originates from Pilismarót-Öregek-dűlő, Komárom-Esztergom County, which consists of 122 graves (Szabó 1975; Szabó 1979; Szentpéteri 2002; see cat. 41) (**App. Fig. 25.**). In nine graves of the cemetery Pilismarót-Basaharc bells and pellet bells

were excavated. All these graves date to the Late Avar Period. The cemetery has 197 graves (Fettich 1965; Szentpéteri 2002; see cat. 42–51) (**App. Fig. 26.**). Three sites with idiophones are located in Pest County: Solymár, Szob-Homok-dűlő and Újhartyán. The Solymár cemetery with 130 graves contains only one grave with pellet bells, which dates to the Late Avar Period (Török 1994; Szentpéteri 2002; see cat. 53–54) (**App. Fig. 18.**).



Fig. 2.: Overview map of the bells and pellet bells discussed in this article and their locations (Map: Public Domain; graphic: B. M. Pomberger).

2. ábra: A cikkben tárgyalt csengők és csörgők lelőhelyei (térkép: Public Domain, rajz: B. M. Pomberger)

Two Late Avar Period graves with pellet bells were found in the cemetery Szob-Homok-dűlő with a total of 142 graves (Kovrig 1975; Szentpéteri 2002; see cat. 59–60) (**App. Fig. 28.**). One further pellet bell was unearthed in an unknown grave in Újhartyán (unpublished; Szentpéteri 2002; see cat. 61) (**App. Fig. 18.**). The cemetery in Edelstal, Burgenland, Austria, contains 257 graves, dating to the periods MAP II–LAP. Pellet bells were excavated in three graves (Lobinger 2016; see cat. 3–5) (**App. Fig. 19.**). At least six pellet bells from so far unknown sites have to be mentioned (cat. 62–67) (**App. Fig. 29.**).

Figure 2 shows an overview map of the sites and the number of bells and pellet bells discussed in this article (**Fig. 2.**). Among the sites the cemeteries of Halimba-Belátó-domb peaks out with 15 idiophones, followed by the cemeteries of Pilismarót with a total of eleven and Kőlked-Feketekapu A with eight idiophones. The cemetery of Kiskőrös-Vágóhídi-dűlő with 15 tiny gold- and silver-sheet bells, worn as jewellery, and one pellet bell is unique. And we must also mention Keszthely with a total of 37 known pellet bells, which will be discussed in a subsequent paper.

Who was buried with bells and pellet bells and in which position were the idiophones found?

67 idiophones are to be discussed. The authors have no further information about 16 of them and their storage location and know them only through the relevant literature (see cat. 1, 23, 32–38, 44–49, 54). The idiophones from grave 81 Edelstal and from the graves 256 and 257 cemetery Pilismarót-Basaharc are lost (Lobinger 2016, 111, 164; Fettich 1965, 88). The sixteen sites together count 33 children's burials, six female and six male, one adult burial and three burials without any information about age or sex. Three of the children belong to the anthropological age infans II, ten are age infans I and the remaining 20 are not further determined. Among the children's burials there are eight girls and three boys. The remaining children's skeletons are not determined about their sex (**Fig. 3.**). But at least, we have to mention that only a vanishingly small group of the deceased had bells with them (**Fig. 4.**).

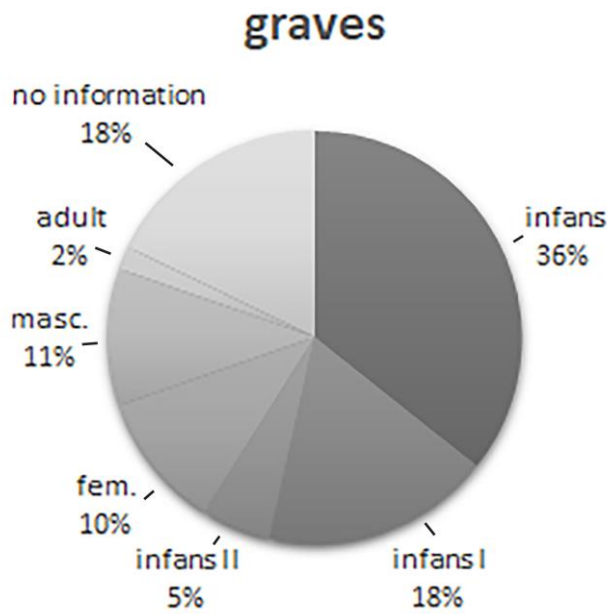


Fig. 3.: Distribution of idiophones (bells and pellet bells) based on the anthropological age of the buried. (Graphic: B. M. Pomberger).

3. ábra: Az eltemetettek antropológiai kora, valamint a csengők és csörgők eloszlása a csoporton belül (rajz: B. M. Pomberger).

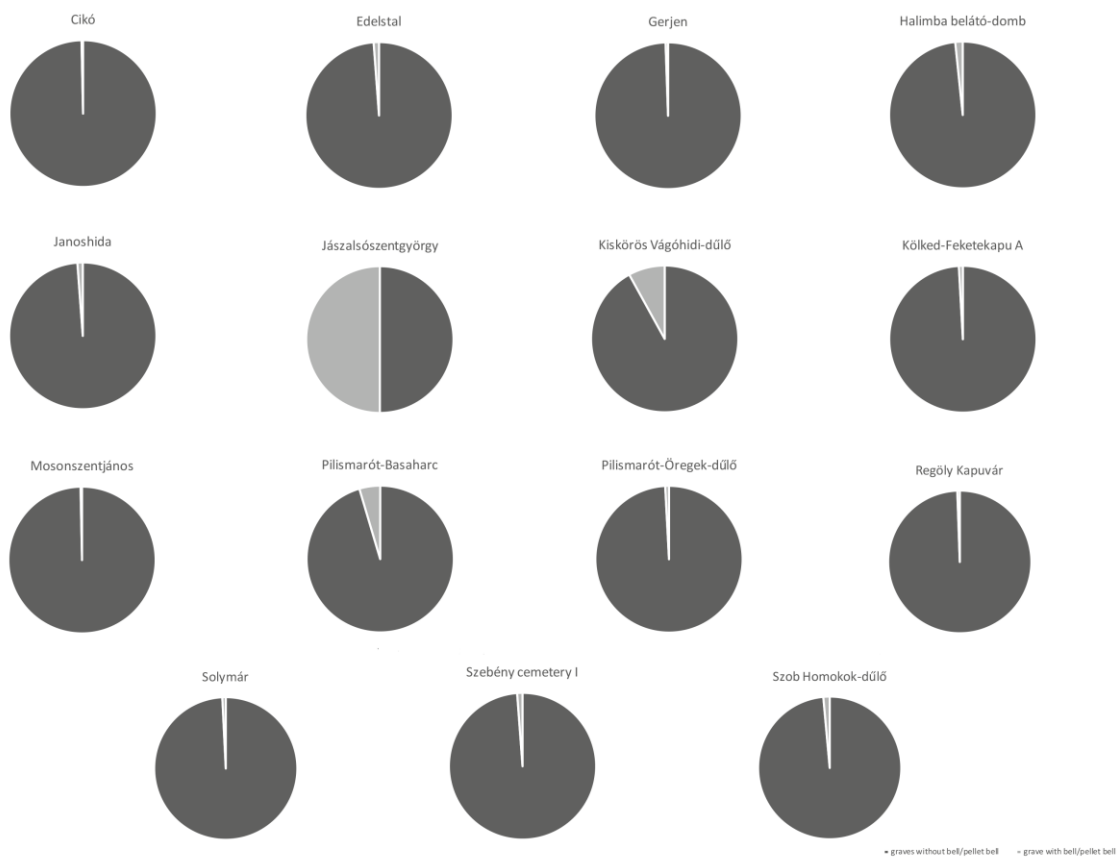


Fig. 4.: The percentage of graves with bells and pellet bells in all observed cemeteries except for Újhartyán (graphic: B. M. Pomberger). Legend: ‘dark grey’ – graves without bells and pellet bells, ‘light grey’ – graves with bells and pellet bells

4. ábra: A vizsgált temetők csengőt és csörgőt tartalmazó sírjainak részaránya, Újhartyán kivételével (rajz: B. M. Pomberger). Jelkulcs: sötétszürke – csengő és/vagy csörgő nélküli sírok, világosszürke – csengőt és/vagy csörgőt tartalmazó sírok

Mostly the pellet bells and bells were found directly near or on the human skeletons. They lay near or under the skull (Jánoshida-Tótképuszta grave 79, Kölked-Feketekapu A grave A-144) (Erdélyi 1958, 18; Kiss 1996, 52) or near or around the neck (Pilismarót-Basaharc grave 256, Halimba-Belátó-domb grave 244) (Fettich 1965, 88; Török 1998, 41). In grave 220 Pilismarót-Basaharc, the pellet bell was near the left shoulder (Török 1998, 74). The deceased girl of grave 8 Kiskörös-Vágóhídi-dűlő wore the tiny bells together with other jewellery on the neck/chest area. Pellet bells were detected near the right elbow (Pilismarót-Basaharc grave 217) (Török 1998, 73), near the left forearm (Kölked-Feketekapu A, grave A-91) (Kiss 1996, 38) and very often near the hands (Cikó grave 499, Halimba-Belátó-domb graves 172 and 457, Pilismarót-Basaharc grave 211, Szob-Homok-dűlő grave 99) (Kiss & Somogyi 1984, 62; Fettich 1965, 72; Kovrig 1975, 180–181). The buried individuals of grave 77 Gerjen and grave 4 Pilismarót-Basaharc held the pellet bell and bell in their right hand (Kiss & Somogyi 1984, 109; Fettich 1965, 10–11). Another find position is near the pelvis as we can see in grave 21 Edelstal, grave 81 Halimba-Belátó-domb and grave A-341 Kölked-Feketekapu A (Lobinger 2016, 156; Török 1998, 25; Kiss 1996, 95). Some idiophones lay near the knee or below the knee bend (graves 17, 50, 392 Halimba-Belátó-domb) (Török 1998, 18, 21, 54). They were also found on the leg (grave 172 Halimba-Belátó-domb) (Török 1998, 33–34), between, near the legs, on in and outer side (grave 393 Halimba-Belátó-domb, grave A-139 Kölked-Feketekapu A, grave 86, 241 and 257 Pilismarót-Basaharc, grave 33 Kiskörös-Vágóhídi-dűlő, grave 183 Szebény, grave 52 Pilismarót-Öregek-dűlő) (Török 1998, 54; Kiss 1996, 51; Fettich 1965, 40, 82, 88; László 1955, 33; Szabó 1975, 256). The bell from grave A-12 Kölked-Feketekapu A was detected in the grave filling and in grave 230 Jánoshida-Tótképuszta, in the middle of the grave, might indicate that both were belonged directly to the deceased individuals. Only in the Early Avar Period grave A-471 from Kölked-Feketekapu A, the three bells had a special place in the grave. They lay in the upper left corner of the grave pit, that means in the right side above the head of the buried man (Kiss 1996, 126–127). The only parallel find, in which bells were found in

a similar position, is the grave of a small girl, grave 157 Vösendorf-Laxenburgerstraße in Lower Austria (Sauer 2007, 86; Pomberger & Stadler 2018a, 228).

Sizes and conditions of conservation

The sizes of the pellet bells vary from 27 up to 46 mm with handle, and from 18 up to 34 mm only for the sound body. The diameters measure for the oval shaped ones from 19 x 24 mm to 30 x 32 mm and for round shaped ones from 18 mm to 32 mm. The wall thickness is between 0.5–2 mm and the conserved weight lies from 9 to 35 g. The bells show sizes with handles from 18 to 11 mm, without handle from 7 to 90 mm. Rectangle bases measure from 22 x 26 mm up to 64 x 76 mm. The round bases have diameters from 20 mm up to 30 mm. The wall thickness measures 5–8 mm and the conserved weight is between 5 g and 37 g.

Tiny bells made from gold and silver sheet have sizes between 8 mm and 19 mm for the sound body, and in total 11–27 mm. The diameters vary from 5 to 8 mm. The weight per tiny bell is between 0.415 g to 0.89 g (Fig. 5).

About one third of the idiophones have intact sound bodies with or without handles. Another five pieces have complete, but deformed sound bodies. But the majority is fragmented, shows holes and cracks in the mantle. All iron idiophones are corroded and some of them are filled with material. Maybe the rattle bodies are still inside the sound body or corroded on the wall. 11 pellet bells still have their rattles bodies. Those are small pebbles, pieces of cinder or small bronze balls. The iron bell clappers mostly are corroded. Only two forged clappers survived in their bells (grave 499 Cikó, grave 4 Pilismarót-Basaharc). Clapper formed of wire are found in the gold- and silver-sheet bells of Kiskörös-Vágóhídi-dűlő and the bell from grave 457 Halimba-Belátó-domb. Two interlocked chain links served as clapper in only one bell. Rests of textiles are conserved on six pellet bells. Probably the four pellet bells from Pilismarót-Basaharc also have traces of textiles, but they were not examined and only known through literature by the author (Fettich 1965, figs. 122, 124).

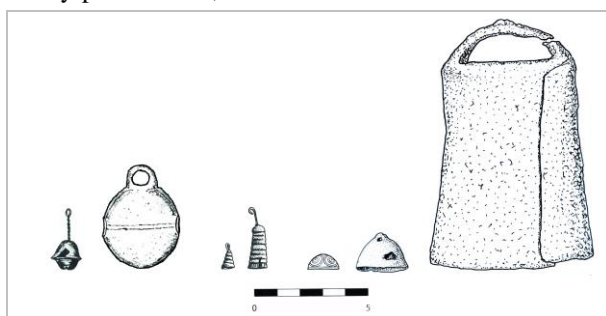


Fig. 5.: Sizes of pellet bells and bells (graphic: B. M. Pomberger, own and after Kiss & Somogyi 1984, pl. 48; Garam 1993, pl. 50/15, 51/14; Kiss 1996, pl. 14, 40, 84).

5. ábra: A csörgők és a csengők mérete (rajz: B. M. Pomberger, saját adatok és Kiss & Somogyi 1984, pl. 48; Garam 1993, pl. 50/15, 51/14; Kiss 1996, pl. 14, 40, 84 nyomán)

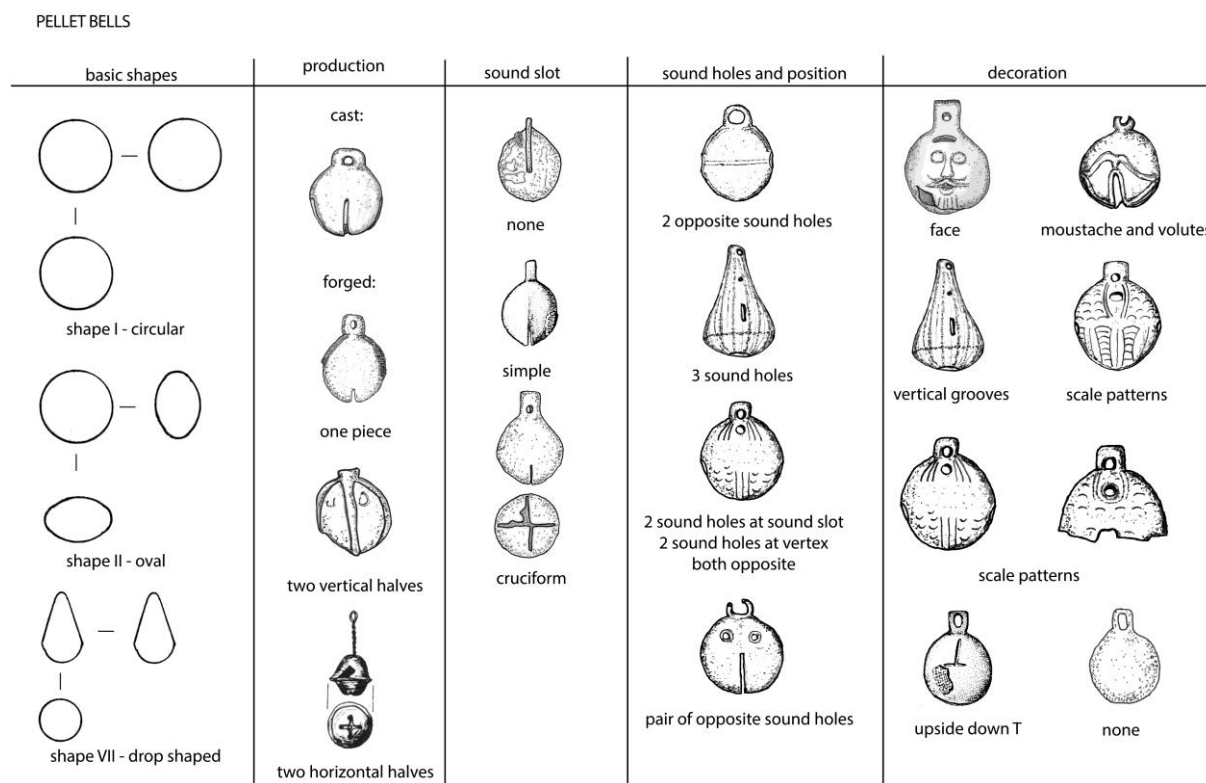


Fig. 6.: Pellet bells: basic shapes, decoration, sound slots and sound holes (graphic: B. M. Pomberger, own and after Kiss & Somogyi 1984, pl. 48/77/6; Lobinger 2016, pl. 16/10).

6. ábra: Csörgők: alapformák, díszítés, hangrés és hanglyukak (rajz: B. M. Pomberger, saját adatok és Kiss & Somogyi 1984, pl. 48/77/6; Lobinger 2016, pl. 16/10 nyomán)

Types, shapes of pellet bells, bells and ornaments

Pellet bells and bells are produced by casting copper alloy in lost wax technique or by forging metal sheet. Until the 19th century metal sheet was forged by hand and therefore it has to be mentioned that this technique was common during the Early Middle Ages. The basic technology of milling metal sheet was invented during the 19th century and improved during the 20th century (see www.azreferate.com).

The basic shapes of the pellet bells examined in this article are represented by shape I (round-circular), shape II (round-oval) and shape VIII (drop-shaped) (Pomberger 2020). While cast pellet bells are produced in one piece, forged pellet bells can be produced from one piece, from two vertical halves or two horizontal halves that are soldered together. These can be soldered together by laying the edges of the halves on top of each other or by forging a plug-in system forming a belt. There are pieces showing a simple sound slot, a cruciform or no

sound slot. The so-called sound holes are placed opposite at the ends of the sound slots, or two holes opposite at the vertex. Some pellet bells have two pairs of sound holes opposite at the vertex. But there are also pellet bells without any sound holes. Usually the sound holes are round. Only the drop-shaped pellet bell from grave 30, cemetery Szébény, has two quadrangular and one round sound hole.

The majority of the pellet bells have smooth surfaces and no decoration. The pellet bell from grave 107, cemetery Jánoshida-Tótképuszta, is decorated with a face. The pellet bells from grave 228, cemetery Szébény, has volutes shaped like a moustache and volutes highlighting the sound slot. Three pellet bells are ornamented with scale patterns (MNM 50.1891.102/cat.64, MNM 62.149.9/cat.65, MNM 1961.82.1/cat.67, all from unknown sites) and one has vertical grooves (grave 30, Szébény). Unique is the upside-down T on the pellet bell from grave 21, Edelstal (see **Fig. 6.**).

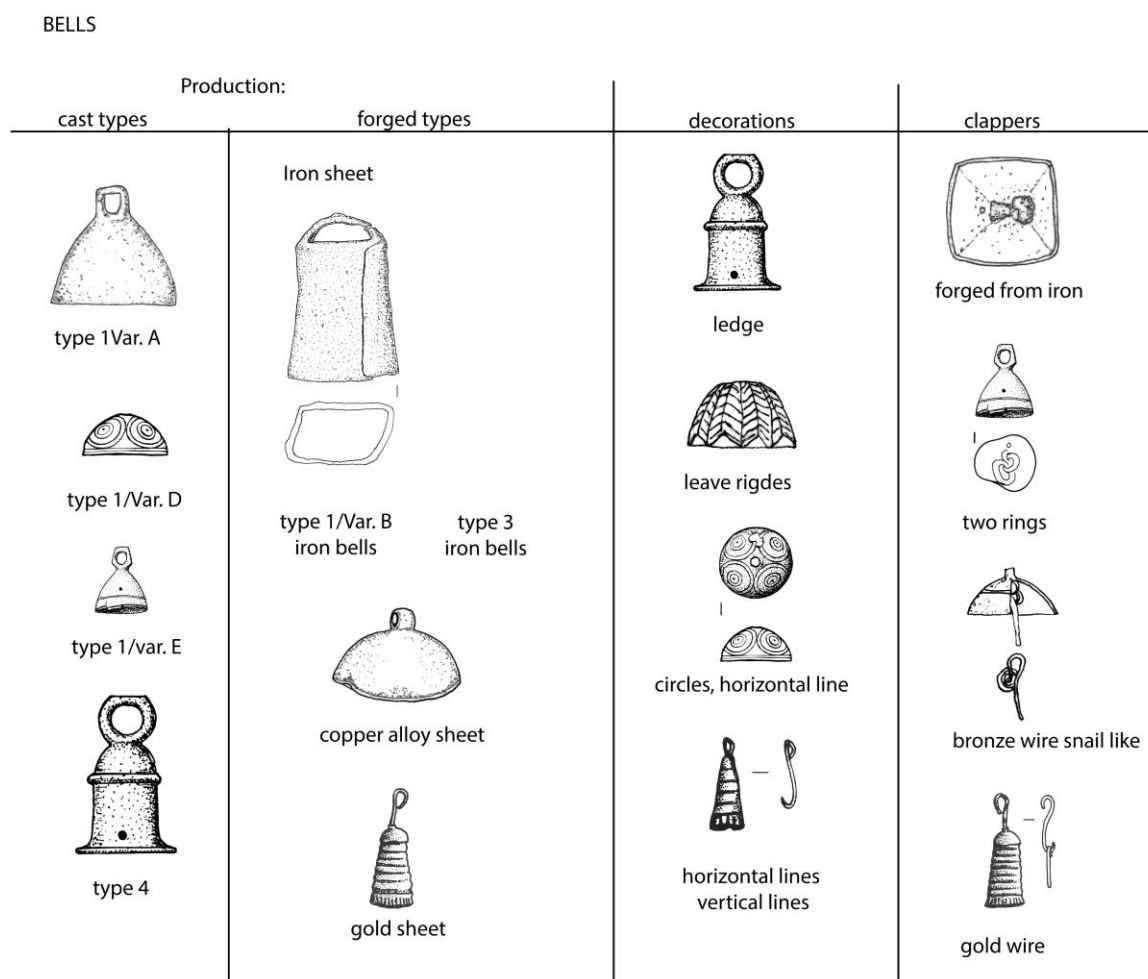


Fig. 7.: Bells: types, decorations and clappers (graphic: B. M. Pomberger, own and after Török 1998, pl. 46/457/2; Kiss 1996, pl. 14. 20, 32, 84; Garam 1993, 48/15, 50/12, 52/3).

7. ábra: Csengők: típusok, díszítések és nyelvek (rajz: B. M. Pomberger, saját adatok és Török 1998, pl. 46/457/2; Kiss 1996, pl. 14. 20, 32, 84; Garam 1993, 48/15, 50/12, 52/3 nyomán)

Pebbles, like the one from the pellet bell, grave 457, Halimba-Belátó-domb, with a diameter of 8 x 6 mm, pieces of copper alloy cinder (grave 228, Szebény), and balls of copper alloy with sizes of 9 mm (grave 79, Jánoshida-Tótképuszta) serve as rattle bodies.

The ancient Roman bell types primarily continue during the Avar period. We mostly find cast bells with circular base and hemispherical body and rectangular base with pyramidal bodies. Forged bells show rectangular base with trapezoidal body, oval base with trapezoidal body and circular base with hemispherical body (Pomberger & Stadler 2018b, 236–237, 239, Abb. 12). The types of the bells cast from the Avar sites discussed are represented by type 1, variant A (bell, grave unknown, cemetery Pilismarót-Basaharc, grave A-144, Kölked-Feketekapu A), variant D (grave A-12, Kölked-Feketekapu A), variant E (grave A-139, Kölked-Feketekapu A) and type 4 (grave A-91, Kölked-Feketekapu A).

Forged bells are represented by the iron bell type 1, variant B (bell C grave A-471, Kölked-Feketekapu A; grave 499, Cikó; grave 32, Solymár; grave 4, Pilismarót-Basaharc, grave 183, Szebény), furthermore by type 3 (bell A grave A-471, Kölked-Feketekapu A), a hemispherical bell type from brass sheet (grave C, Regöly-Kapuvár) and copper alloy sheet (grave 457, Halimba-Belátó-domb), and a small truncated-cone gold-sheet bell type (graves 3, 8, 17, 41 and 67, Kiskörös-Vágóhídi-dűlő). The bell from grave 4, Pilismarót-Basaharc, is covered with a copper alloy, probably to protect the iron sheet from corrosion. The handles are shaped rectangular, round, trapezoidal or strap handles like on the iron sheet bells. The surface can be smooth, decorated with leaf ridges, with circles and horizontal lines, vertical lines or a structured by a ledge. Usually the clappers are forged by iron, but there are also two chain links serving as clapper and clappers bent from bronze or gold wire (Fig. 7.).

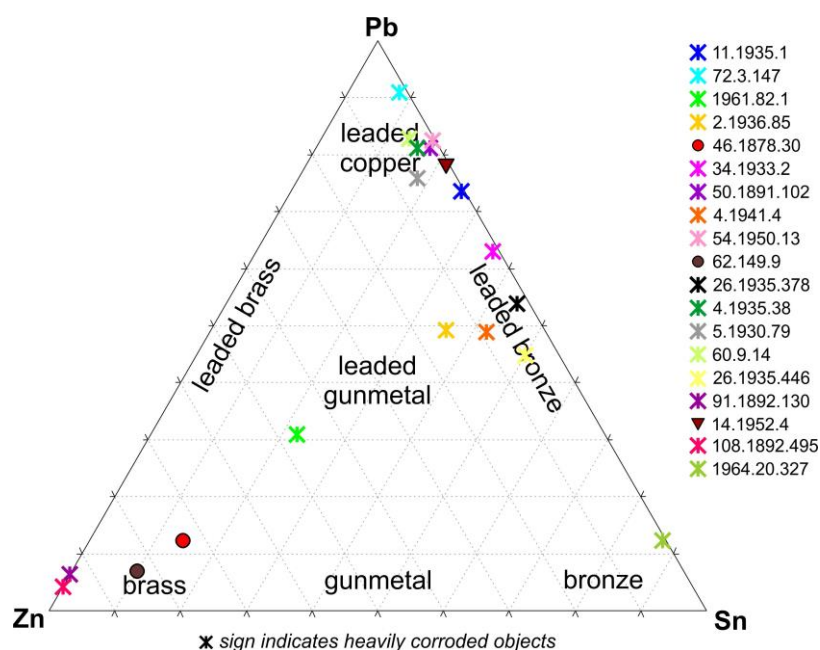


Fig. 8.: Chemical composition of the metallic idiophones from the Hungarian National Museum (Budapest) plotted on the Sn-Pb-Zn ternary diagram (after Bayley 1989). During corrosion processes lead and tin contents increase, whereas zinc content decreases towards the surface (graphic: V. Mozgai).

8. ábra: A Magyar Nemzeti Múzeum gyűjteményéből vizsgált fémidiofonok kémiai összetétele az Sn-Pb-Zn háromszögdiagramon (Bayley 1989 nyomán). A rézötvözetanyagok korróziója során az ólom- és az óntartalom növekszik, míg a cinktartalom csökken a felszín felé (rajz: Mozgai V.).

Chemical analyses

The chemical analyses were carried out non-destructively by using a handheld XRF (SPECTRO xSORT Combi handheld XRF spectrometer, 15–50 kV, 30–120 μ A, Rh anode, SDD detector, 'Light Elements' built-in calibration, measurement area 3 mm in diameter, 60 sec measurement time). 19 objects are listed in **Table 1** were measured. The analysed metallic idiophones were manufactured from different types of copper alloys: mainly brass, leaded copper, leaded bronze, and one leaded gunmetal and one bronze (**Fig. 8.**, **Table 1.**). The composition of the alloys is very heterogeneous, generally the measured content of the alloying elements (Pb, Zn, Sn) is very high. It can be due to corrosion processes (especially in the case of Pb and Sn, which can be enriched in the surface layer of the objects), or manufacturing processes (e.g., to enhance sounding). One of the bells (MNM 1964.20.327/cat. 15) was decorated with gilding. Mercury was detected in the gilded areas indicating the use of fire gilding.

Acoustic and psychoacoustic analyses

Audio recordings from two bells and six pellet bells have been analysed for their acoustic and psychoacoustic properties using Adobe Audition and HEAD ArtemiSuite. Acoustic analyses are mainly to understand the physics of sound like distribution of partials, spectral shape, emitted sound pressure levels or temporal structure, i.e. excitation and decay.

Psychoacoustics, on the other hand, seeks to predict more subjective parameters like loudness, brightness, sharpness or tonality by applying computer models that make use of a variety of single audio features that represent the parameters mentioned. The combination of both analyses helps to describe the sounds in an accurate yet easy to understand way.

Overall, the (pellet) bells spectra range from about 1 kHz all the way up to the upper limit of human hearing, which is about 20 kHz. However, frequencies higher than 10 kHz hardly shape the sound but rather add up to the perception of brightness.

Partial frequencies are distinct frequencies that stick out of the spectrum in amplitude, depending on the vibrational modes of the sounding object. The idiophones' sound is not harmonic, i.e. partials are not integer multiples of one single fundamental but consist of multiple circular and axial modes. The partials can be described with the signal-to-noise ratio (SNR), which is the distance in amplitude between the background noise and stronger partials.

Bells usually produce less partials than pellet bells, but more pronounced ones. In pellet bells the noise proportion is typically higher. Bells and pellet bells differ greatly in excitation even though the process itself is physically quite similar (a clapper or pellet hitting the surface, which makes it an impulsive sound). While small bells are hit by the clapper for about 4–7 times per second when rung, the pellet hits the inner walls roughly 15–30 times per second, creating the typical and well-known sound.

Table 1.: Chemical compositions of the metallic idiophones from the Hungarian National Museum (Budapest) measured by hXRF. The results are in weight%. LOD = limit of detection. The elevated Fe, Al, Si, P and S content is due to corrosion processes and soil contamination. MNM 1964.20.327 is gilded (mercury was detected, but not quantified) (graphic: V. Mozgai).

1. táblázat: A Magyar Nemzeti Múzeum gyűjteményéből vizsgált fémidiofonok kézi XRF-fel mért kémiai összetétele. Az adatokat tömeg%-ban adtuk meg. LOD = kimutatási határ. A megnövekedett Fe-, Al-, Si-, P- és S-tartalom a korróziós folyamatok és a talajszennyeződés eredménye. Az MNM 1964.20.327 tárgy aranyozott (higany jelenlétét kimutattuk pontos mennyiségi meghatározás nélkül) (a táblázatot összeállította: Mozgai V.).

Cat. No.	MNM Inv. nr.	Object	Cu	Sn	Pb	Zn	Au	Fe	Ag	Sb	Al	Si	P	S
25	11.1935.1	pellet bell	68.2	4.2	11.8	0.1	< LOD	5.2	< LOD	0.5	1.5	1.4	6.2	< LOD
53	72.3.147	pellet bell	71.2	2.0	23.7	0.3	< LOD	0.1	2.5	0.1	< LOD	< LOD	< LOD	< LOD
67	1961.82.1	pellet bell	54.1	8.3	11.5	17.4	< LOD	1.5	< LOD	0.0	0.8	3.7	2.5	< LOD
55	2.1936.85	pellet bell	58.2	11.7	16.1	4.9	< LOD	1.6	< LOD	0.1	1.4	1.2	1.6	< LOD
63	46.1878.30	pellet bell	59.3	3.9	3.4	20.3	< LOD	0.4	< LOD	0.2	3.6	6.3	1.9	0.3
61	34.1923.2	pellet bell	65.6	9.8	17.0	0.3	0.1	1.4	0.2	0.2	< LOD	0.2	4.8	< LOD
64	50.1891.102	pellet bell	57.4	6.3	29.8	0.5	0.1	4.5	0.3	0.2	< LOD	< LOD	< LOD	< LOD
43	4.1941.4	bell	49.0	19.2	22.3	4.1	< LOD	0.3	0.2	0.1	0.7	1.0	1.8	< LOD
66	54.1950.13	pellet bell	45.4	8.4	40.7	0.2	< LOD	1.6	0.1	0.2	0.4	< LOD	2.3	< LOD
65	62.149.9	pellet bell	68.7	2.8	2.0	23.7	< LOD	0.3	< LOD	0.1	< LOD	0.4	0.3	1.8
57	26.935.378	pellet bell	43.1	22.8	27.6	1.0	< LOD	0.6	0.6	0.4	1.0	2.1	0.8	< LOD
26	4.1935.38	pellet bell	57.7	4.2	22.2	0.9	0.1	0.3	0.4	0.2	0.5	11.6	1.6	< LOD
2	5.1930.79	pellet bell	28.6	10.9	45.9	3.7	< LOD	7.2	0.2	0.3	0.4	2.3	< LOD	< LOD
22	60.9.14	pellet bell	40.4	5.9	36.6	1.7	< LOD	2.4	1.5	0.2	1.0	9.7	0.4	< LOD
58	26.1935.446	pellet bell	84.6	5.7	5.1	0.6	< LOD	0.3	< LOD	< LOD	0.8	2.4	0.1	< LOD
52	91.1892.130	bell	78.5	< LOD	0.6	9.1	< LOD	0.2	0.2	< LOD	1.2	3.8	5.1	0.8
62	14.1952.4	pellet bell	74.7	4.0	14.7	0.1	< LOD	0.3	< LOD	0.5	1.7	3.1	0.4	< LOD
6	108.1892.495	Pellet bell	81.1	< LOD	0.4	9.2	< LOD	0.4	< LOD	0.1	1.1	3.1	3.7	0.9
15	1964.20.327	bell	77.7	15.5	2.2	0.1	0.7	0.1	0.0	< LOD	< LOD	0.8	1.3	0.5
15	1964.20.327	bell - gilding	60.2	14.6	1.0	< LOD	22.4	0.2	0.2	0.1	< LOD	1.0	< LOD	< LOD

This allows the bells to vibrate freely between the single hits and give them a “clearer” sound with less noise components. In the moment of impact, a broad range of frequencies are excited and only a few milliseconds later, the partials form according to the modes of the object.

Figure 9 shows the spectra of MNM 4.1941.4 (cat. 43), which is typical for a small bell and MNM 72.3.147 (cat.53), which is typical for a pellet bell. Both graphs showcase the differences between the types as mentioned above.

Generally, the objects are quite high in sound pressure level (SPL), which is the physical measure for intensity of sound. Corrosion and other physical destruction greatly dampen the sound emission, the most silent pellet bells (MNM 26.1935.378/cat.57) and MNM 1964.20.326_c/cat.14) hardly even reach 30 dB at a distance of 1 m. This level is easily masked even by the slightest rustling of leaves. Spectra show that hardly any sound is produced (see **Fig. 10**).

The recordings were made in a distance of about 10 cm to the object, all calculated values in the next paragraph represent that distance if not marked otherwise. Sound pressure level decreases by 6 dB when the distance to a source is doubled (Attenborough 2014, 119), which makes it possible to approximately calculate the maximum audible distance for sound objects for known levels of background noise. Depending in noise levels the 8 pellet bells can be heard in a distance of 1 to maximum 12–15 meters. SPL is linked but not to be mistaken with the subjective perception of loudness. The human ear is insensitive to very high or low frequencies but especially sensitive in the range of 2 to 4–5 kHz. Since mere SPL values do not take hearing curves into consideration, the psychoacoustic parameter “loudness” is used. Loudness comparisons were introduced in the 1920s (Fastl & Zwicker, 2007, 203). Zwicker

introduced the today very common sone scale (Völz 1999, 51). At 1 kHz 40 dB SPL equal a loudness of 1 sone or 40 phon. A sound with 2 sone is considered to be twice as loud as a sound with 1 sone – doubling the actual values means doubling the loudness.

The 8 recorded pellet bells range from 3–28 sone, which means the louder ones are about 10 times as loud. This can also be visualized by the spectrogram, which shows the amplitudes and frequencies over time (see **Fig. 11**).

Other psychoacoustic parameters are also useful in describing the timbre of sounds, for instance brightness, sharpness, roughness or tonality. Brightness (bright-dark) is a simple measure of the spectral center of gravity (SC), which is represented by a frequency that divides the spectrum into two equal parts (in terms of energy). This parameter is highly correlated with the subjective perception (Schubert et al. 2004, 656). Unsurprisingly, an SC ranges between 3.5–5 kHz could be found for pellet bells and 6–8.8 kHz for the bells, where higher values stand for brighter sounds. Noise content has more affect in lower frequencies that is why pellet bells are usually lower in brightness.

Sharpness depends on the spectral density and envelope and especially the frequency range between 2–5 kHz. This parameter also represents pleasantness quite well. It is measured in acum and defined as a 1 kHz critical band noise of 60 dB being 1 acum (Fastl & Zwicker 2007, 241). Higher values stand for more sharpness. In contrast to this merely spectral parameter, roughness represents the temporal fluctuations of a sound, i.e. amplitude modulations. Slow modulations (< 15 Hz) create a beat frequency, higher modulations create the impression of roughness, reaching its maximum at 70 Hz and disappearing at >150 Hz (Fastl & Zwicker 2007, 257). It is measured in asper, being a value between 0 and 1.

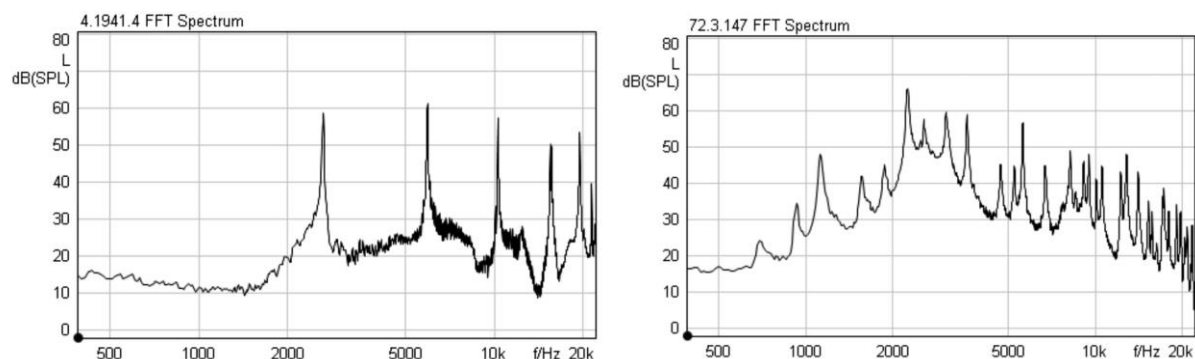


Fig. 9.: Acoustic spectra of bell MNM 4.1941.4 (left) and pellet bell MNM 72.3.147 (right), 4096 window size, Hanning (graphic: J. Mühlhans).

9. ábra: Az MNM 4.1941.4 csengő (balra) és az MNM 72.3.147 csörgő (jobbra) hangspektruma, 4096 ablakméret, Hanning (rajz: J. Mühlhans)

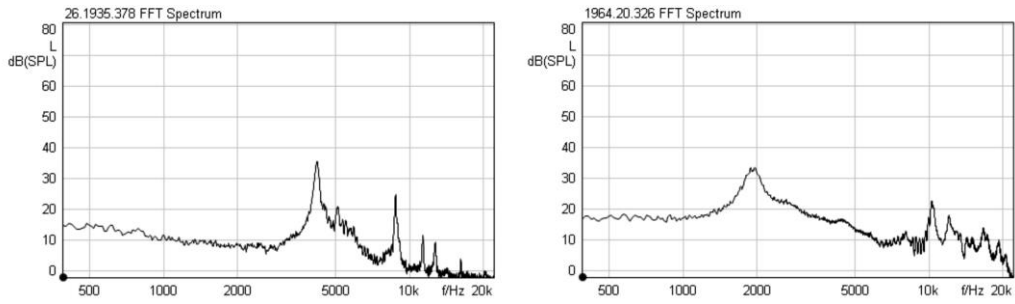


Fig. 10.: Acoustic spectra of pellet bells MNM 26.1935.37 (left) and MNM 1964.20.326 (right), 4096 window size, Hanning (graphic: J. Mühlhans).

10. ábra: Az MNM 26.1935.37 (balra) és az MNM 1964.20.326 (jobbra) csörgők hangspektruma, 4096 ablakméret, Hanning (rajz: J. Mühlhans)

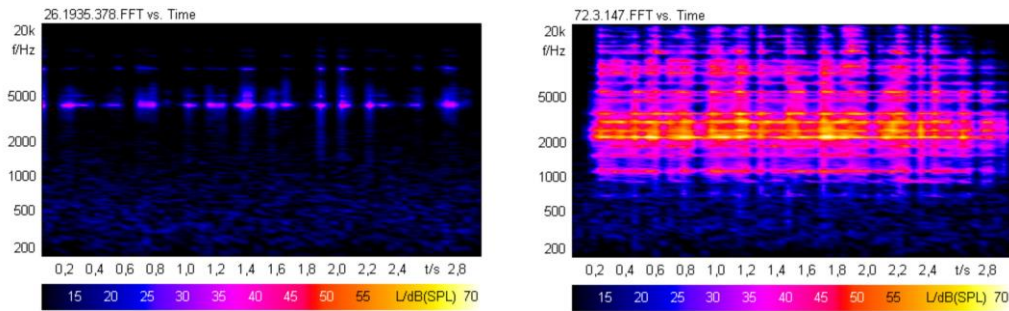


Fig. 11.: Frequency spectrogram of pellet bells 26.1935.378 (left) and 72.3.147 (right). 4096 window size, 85% overlap, Hanning. Dark areas indicate no/very low amplitude, yellow areas very high ones (graphic: J. Mühlhans)

11. ábra: A 26.1935.378 (balra) és a 72.3.147 (jobbra) csörgők frekvenciatartománya, 4096 ablakméret, 85/ átfedés, Hanning. A sötét területek nagyon kicsi amplitúdót vagy az amplitúdó hiányát, a sárga területek a nagyon magas amplitúdót mutatják (rajz: J. Mühlhans)

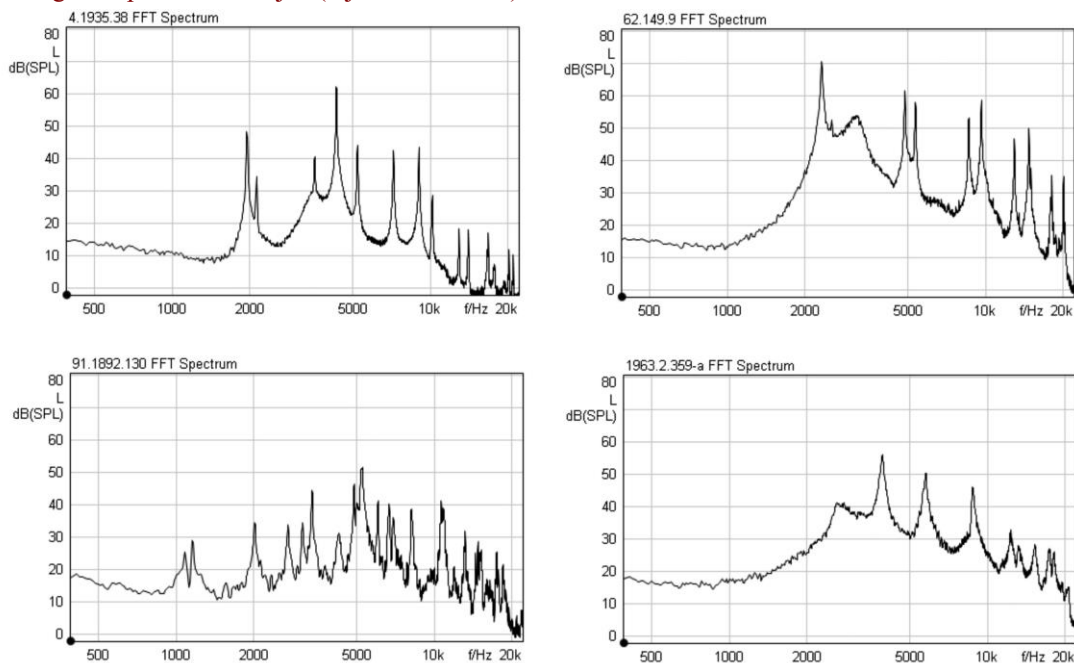


Fig. 12.: Acoustic spectra of pellet bells MNM 4.1935.38 (cat. 26), MNM 62.149.9 (cat. 65), MNM 1963.2.359_a (cat. 10) and bell MNM 91.1892.130 (cat. 52) (graphic: J. Mühlhans).

12. ábra: Az MNM 4.1935.38 (kat. 26), az MNM 62.149.9 (kat. 65), az MNM 1963.2.359_a (kat. 10) csörgők és az MNM 91.1892.130 (kat. 52) csengő hangspektruma (rajz: J. Mühlhans)

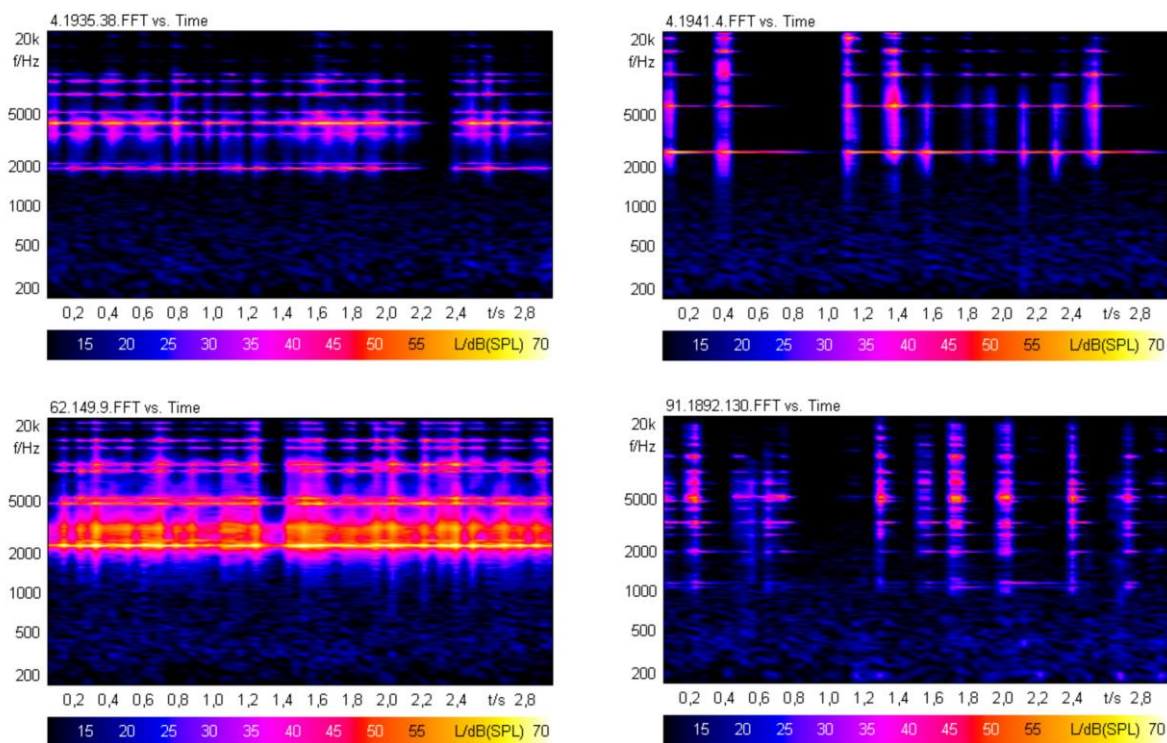


Fig. 13.: Frequency spectrogram of pellet bells MNM 4.1935 (cat. 26), MNM 62.149.9 (cat. 65) and bells MNM 4.1941.4 (cat. 43) and MNM 91.1892.130 (cat. 52) (graphic: J. Mühlhans).

13. ábra: Az MNM 4.1935.38 (kat. 26), az MNM 62.149.9 (kat. 65) csörgők, valamint az MNM 4.1941.4 (kat. 43) és a 91.1892.130 (kat. 52) csengők frekvenciatartománya (rajz: J. Mühlhans)

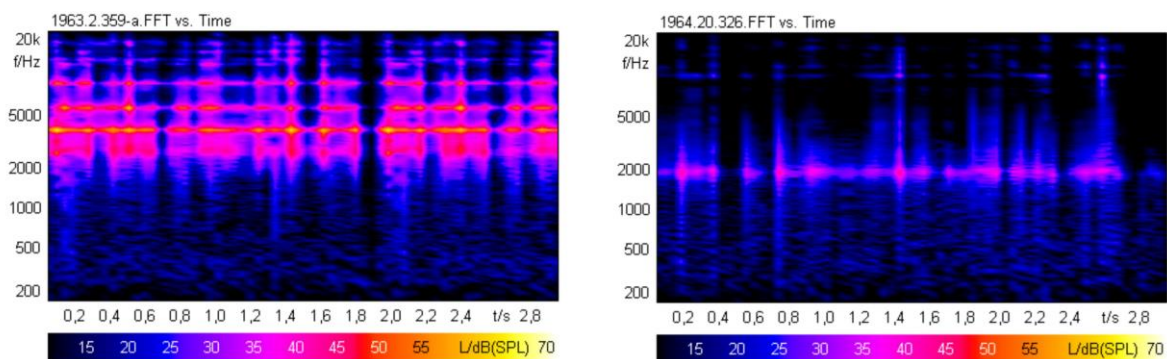


Fig. 14.: Frequency spectrogram of pellet bells MNM 1963.2.359_a (cat. 10) and MNM 1964.20.326_c (cat. 14) (graphic: J. Mühlhans).

14. ábra: Az MNM 1963.2.359_a (kat. 10) és az MNM 1964.20.326_c (kat. 14) csörgők frekvenciatartománya (rajz: J. Mühlhans)

In these two parameters the pellet bells and bells show no differences. With values between 0.02–0.1 asper and 2.5–4.5 acum the eight objects can be described as not rough at all, but quite sharp.

Last but not least, tonality shows the tone-noise-ratio as a psychoacoustic parameter (Becker et al. 2019, 5820), where 0 dB stands for an equal distribution of tone (harmonic) and noise, positive values indicate more tonal components and negative values more noise. The higher the numerical value in the positive range, the more

tonal the measured sound. Bells with more pronounced partials range between 14–20 dB, the others around 4–8 dB, which is hardly more tonal than noise components (see **Table 2, Figs. 12–15**).

Textiles

Textile analyses were carried out on nine iron pellet bells deriving from Halimba-Belátó-domb tombs 17, 244, and 393, Jánoshida tomb 230, Kölked-Feketekapu tomb A-342, Pilismarót-Öregek-dűlő tomb 52, and Szob-Homok-dűlő tombs 85 and 99.

Table 2.: Psychoacoustic data of the bells and pellet bells (table compiled by J. Mühlhans)

2. táblázat: Csengők és csörgők pszichoakusztikus adatai (a táblázatot összeállította: J. Mühlhans)

		Cat.		pellet bells	10	14	26	53	57	65	bells	43	52
		MNM Inv.nr.			1963.2.359-a	1964.20.326_c	4.1935.38	72.3.147	26.1935.378	62.149.9		4.1941.4	91.1892.130
Range of Partial	likely audible only		kHz		3.9-8.7	1.9	1.9-9	1.1-13	4.2	2.3-9.7		2.6-20	3.3-10.7
FFT	(average)	Level 10 cm	dB(SPL)		67.69	48.67	65.64	74.47	46.66	76.54		68.51	62.86
FFT	(average)	Level 1 m	dB(SPL)		47.69	28.67	45.64	54.47	26.66	56.54		48.51	42.86
Loudness	vs. Time	N5 10 cm	sones		13.4	4.53	13.6	27.2	3.41	28.2		13.6	9.23
Loudness	vs. Time	N5 1 m	sones		1.675	0.56625	1.7	3.4	0.42625	3.525		1.7	1.15375
Sharpness	vs. Time	S	acum		3.91	2.51	4	4.05	2.82	4.52		3.81	2.98
Roughness	(Hearing Model) vs. Time	R	asper		0.302	0.0912	0.023	0.0698	0.0304	0.103		0.0303	0.0323
Impulsiveness	(Hearing Model) vs. Time	I	iu		5.88	2.31	1.28	2.1	1.45	2.47		1.45	2.37
Tonality	DIN45681	TNR	dB		8.53	4.27	20.5	18.37	10.88	24.07		20.85	13.34
Power Spectral Density	(average)	L	dB(SPL)		67.83	48.44	65.58	74.39	46.72	76.41		68.52	62.61
Specific Impulsiveness	(Hearing Model)	I	iu		6.22	2.46	1.33	2.26	1.5	2.66		1.52	2.49
Sound Power Spectrum		Lw	dB(PWL)		67.73	48.01	65.57	74.24	46.65	76.34		67.36	62.52
Sound Power Spectrum		Lw(A)	dB(PWL)		68.33	48.75	66.49	75.27	47.42	77.33		67.31	62.78
Specific Roughness	(Hearing Model)	R	asper		0.363	0.126	0.0412	0.0995	0.0587	0.15		0.0476	0.0589
Tonality	(Hearing Model) vs. Time	TonalityHMS [0,304-3 s]	tuHMS		0.726	0	2.16	1.84	0.248	2.57		1.73	0.713
Specific Loudness		N	sonesGF		15	5.11	11.7	24.2	3.75	25.2		13	10.1
Specific Tonality	(Hearing Model)	TonalityHMS [0,304-3 s]	tuHMS		0.726	0	2.16	1.84	0.248	2.57		1.73	0.713
Brightness Praat		SC Hz			4966	3968	4409	3522	4576	3543		8879	5920

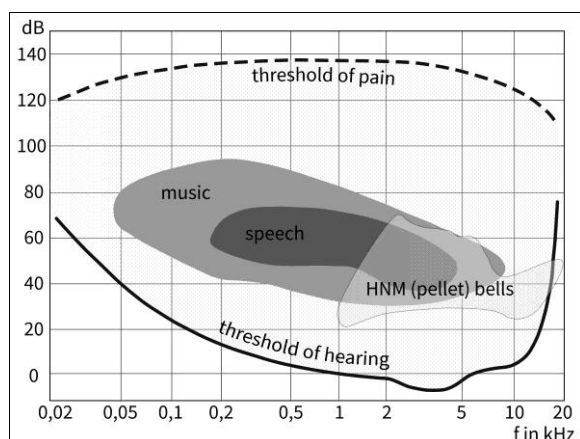


Fig. 15.: Human auditory and bells (graphic: J. Mühlhans)

15. ábra: Az emberi hallás és a csengők (rajz: J. Mühlhans)

They were preserved in a mineralised state due to the contact with the pellet bells in the tomb. During the mineralisation process, the metallic salts penetrate the fabric, sometimes degrading and replacing the organic substance completely, yet maintaining the textile structure to varying degrees (Mitschke 2001, 29–30). The structures and qualities of the textiles were documented using a digital microscope (DinoLite digital microscope), which allows magnifications between 30x and 250x. The corresponding software enables the determination of the diameter and twist of the thread, as well as the identification of features such as seams, sewing threads and creases.

All of the analysed textiles are tabby weaves woven with yarn with an average thread diameter of 0.44 mm and an average thread count of 19–20 per cm, both excluding one outlier. All threads are z-spun in 30° on average, with the exception of one textile in tomb 393 Halimba-Belátó-domb, which has only s-spun threads. These features are characteristic for textiles of the Avar period (Hundt 1984; Grömer & Rapan Papeša 2014; Grömer 2015).

In the following paragraphs, some of the significant analysed textiles are presented.

Skin and textile on the neck?

The iron pellet bell in the child's tomb 244 of Halimba-Belátó-domb was located on the right side of the cervical vertebrae (Török 1998, 41). Two organic materials were mineralised onto the object: a textile directly on the pellet bell and a fragment of skin or leather (see Fig. 16a) on top of the textile.

In the mineralised state of the skin, it is difficult to identify the animal it derives from. We cannot exclude that this is human skin from the child's neck, which would mean that the textile was worn directly on the body as a single layer in this area. The grain pattern could possibly be identified as goat's skin or leather (information kindly provided by G. Ruß-Popa, Austrian Academy of Sciences).

One must note that the pellet bell and the clothing could have slipped into this position after the burial. It seems unlikely that the pellet bell was worn around the neck on a strap of skin/leather covered with textile, since these fragments were located on the bottom of the pellet bell.

Perhaps they were two separate pieces of clothing, or part of a piece of clothing with a leather border or strap, or the pellet bell was put into a pouch made of skin and lined with textile. Otherwise, the pellet bell might have been placed beside the body, meaning the skin and the textile could have been laid out under the body.

Layered textile fragments

The multi-layered textiles on the pellet bells are also noteworthy. Three of the analysed pellet bells from Halimba-Belátó-domb grave 17 (at least three layers), Pilismarót-Öregék-dűlő grave 52 (at least four layers), and Szob-Homok-dűlő grave 85 (three layers, see Table 3).

The pellet bell from Halimba-Belátó-domb grave 17 was located under the woman's right knee (Török 1998, 18), likely meaning that the rather fine (0.2–0.25 mm) textile belonged to a dress, which due to its larger circumference in this area (to facilitate leg mobility) can easily crease, wide trousers, or a leg wrap, which would also form multiple layers of fabric. In this case, the pellet bells were perhaps attached to a band that fastened the leg wrap.

The pellet bell in Pilismarót-Öregék-dűlő, tomb 52 (see Fig. 16b) was found near the child's right femur (Szabó 1975, 257), suggesting a similar interpretation for the textile, though the position is too high for it to be a fragment of a leg wrap.

The burial of the child in Szob-Homok-dűlő, grave 85 (see Fig. 16c) contained a pellet bell and belt mounts in the area of the pelvis (Kovrig 1975, 179), indicating that the multiple textile layers might derive from the fabric of, for example, a tunic that was gathered by the belt in this area, thus creating creases.

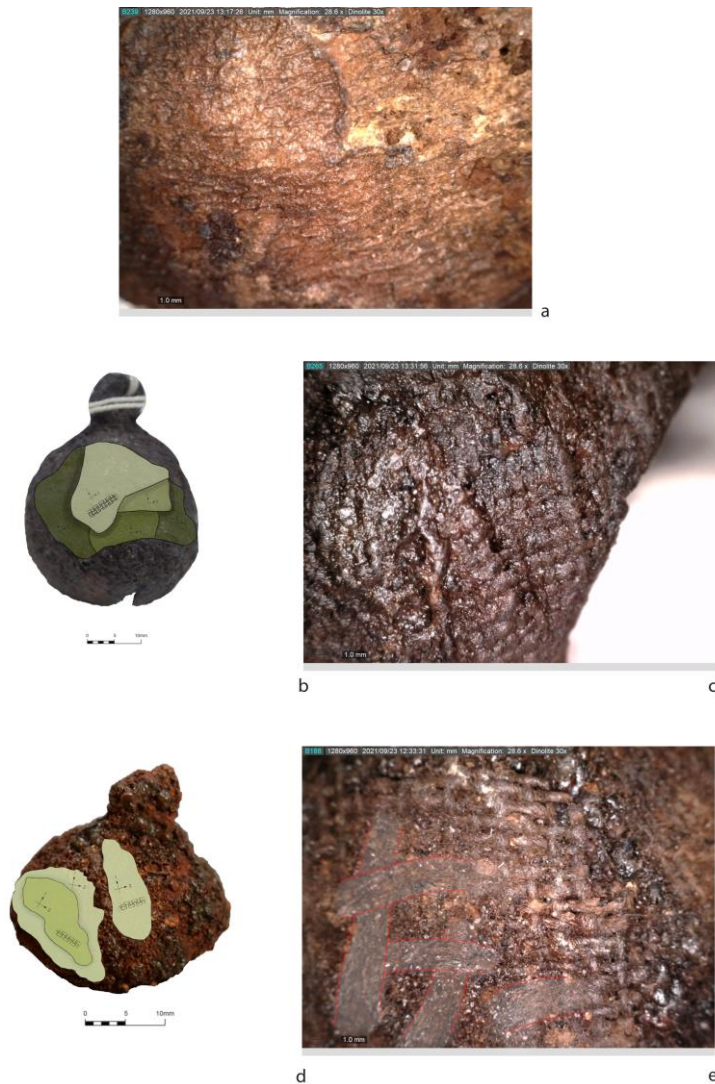


Fig. 16.: a. The leather or skin fragment from Halimba-Belátó-domb, tomb 244; 30x magnification. b. The four visible layers of fabric from Pilismarót-Öregek-dűlő, tomb 52. Lighter colour = upper layer; darker colour = lower layer. c. Multiple textile layers from Szob-Homok-dűlő, tomb 85; 30x magnification. d. The positions of the textiles on the pellet bell from Kölked-Feketekapu A, tomb 342. Lighter colour = finer textile; darker colour = coarser textile. e. The coarser textile (highlighted) on top of the finer fabric; 30x magnification (images: K. Saunderson).

16. ábra: a. Bőrtörödékek Halimba-Belátó-domb 244. sírjából, 30x-os nagyítás, b. A szövet négy látható rétege Pilismarót-Öregek-dűlő 52. sírjából, világosabb szín = felső réteg, sötétebb szín = alsó réteg, c. Többszörös textilrétegek a Szob-Homok-dűlő 85. sírjából, 30x-os nagyítás, d. A textilek helyzete a Kölked-Feketekapu A 342. sír csörgőjén, világosabb szín = finomabb textil, sötétebb szín = durvább textil, e. Durvább szövet (kiemelve) a finomabb szövet tetején, 30x-os nagyítás (képek: K. Saunderson)

A pellet bell hidden under fabric?

The outlier is one of the two textiles on the iron pellet bell in tomb 342 Kölked-Feketekapu A with its 1.5–1.6 mm threads. It partly overlaps the other, finer (0.3–0.45 mm) textile on this object, which seems to have a vertical crease, since after 1.3 mm gap in the textile, the angle of the threads changes by 30° (see **Figs. 16d, e**). Unfortunately, the skeleton was very badly preserved upon excavation, but the pellet bell was probably located on the right side of the pelvis, with the eyelet facing the young child's head (Kiss 1996, 95). The finer textile could well derive from a piece of clothing, e.g., a tunic or kaftan. The crease in the fabric would correspond with this interpretation considering the position of the pellet bell, since it would be expected that a tunic is more loosely fitted in the area of the pelvis.

Alternatively, it could also represent legwear or a bag.

The thicker textile might represent a blanket, which the body was wrapped in, or a piece of outer clothing, such as a mantle, comparable with the finer inner fabric and coarser outer fabric observed among the Avar period textiles of Zwölfaxing, Austria (Grömer 2015, 198). The interpretation of a blanket seems plausible considering the age (infans I) of the buried child.

It is important to emphasise the fact that the thicker textile lies on top of the finer one microstratigraphically. Proceeding on the assumption that the textiles are layers of clothing or a tunic and a blanket, this would mean that the pellet bell was positioned underneath these two fabrics, which makes it unlikely that the pellet bell would have been audible worn under these layers in daily life.

Table 3.: The analysed textiles on pellet bells from the Hungarian National Museum (table compiled by K. Saunderson)

3. táblázat: A Magyar Nemzeti Múzeum csörgőin lévő, jelen cikkben elemzett textilek (a táblázatot összeállította: K. Saunderson)

Site	Tomb Nr.	MNM Inv. Nr.	Twist		Degree of twist		Thread diameter in mm		Thread-count per cm		Weave
Halimba-Belátó-domb	17	63.2.58	z	z	30-40°	40°	0.2-0.25	0.2-0.25	11-12	14-15	Tabby
Halimba-Belátó-domb	244	65.11.237	z	z	30-40°	30-40°	0.5-0.6	0.4-0.6	16-17	20	Tabby
Halimba-Belátó-domb	393	66.20.318a	z	z	30°	20°	0.5-0.6	0.4-0.6	15	16	Tabby
Halimba-Belátó-domb	393	66.20.318b	s	s	30°	30°	0.4-0.5	0.4-0.5	12-14	14-16	Tabby
Jánoshida	230	11.1934.26	z	z	20°	20°	~0.55	~0.55	15-17	15-17	Tabby
Kölked-Feketekapu	342	76.1.342.1	z	z	20-30°	20-30°	0.3-0.45	0.3-0.45	20	22-24	Tabby
Kölked-Feketekapu	342	76.1.342.1	z	-	10-20°	-	1.4-1.6	1.4-1.6	~3	~5	Tabby
Pilismarót-Öregek-dűlő	52	7.1941.32	z	z	30°	30°	0.3-0.5	0.4-0.6	20-21	22	Tabby
Szob-Homok-dűlő	85	21.1936.92	z	z	20-30°	20-30°	0.3-0.4	0.3-0.4	22-24	22-24	Tabby
Szob-Homok-dűlő	99	21.936.148	z	z	30-40°	30-40°	0.3-0.45	0.5-0.65	11-12	10	Tabby

Supposed function of the pellet bells and bells

Pellet bells and bells may have several functions. They are used for practical and ornamental as well as for animist-religious purposes.

Practical purposes – signal instrument

Acted pellet bells and bells worn by people as signal instrument to protect humans against wild animals and warn wild animals of a person approaching? In mountainous regions like the High Tatras and the Carpathians, where populations of bears live, hikers wear pellet bells on their rucksacks to signal the animal their coming. No one wants to be surprised by an angry she-bear with bear cubs! Modern pellet bells designed to repel wild animals or help to acoustically locate e.g., a dog in the forest hardly differ in terms of measurable acoustic parameters. However, the 3 modern pellet bells measured for this study are 32–60 dB higher in SPL at the same distance. This corresponds to a subjective perception of being eight to 60 times (!) louder than the historic ones. It can be assumed that the historic ones were louder without corrosion, but probably not as loud as the modern ones. But since the frequency range covered by a ringing pellet bell quite sticks out of usual background noise (and also other human or animal-made noise) in the woods, a variety of

possible functions, including repelling wild animals is possible. The idiophones also could have been used to help parents to locate their children. But this works only within the range of the instrument.

Another interpretation of metallic idiophones in context with children is that pellet bells and bells in children hands served as sounding toys. It is an open secret that infants are fascinated by the sounds of small pellet bells and bells. Both idiophones as percussion instruments are simple musical toys for children (Deutsch & Walcher 2004, 129–130) and enable first musical experience (Stadler Elmer 1997, 36–37) (**Fig. 17.**). Furthermore, music is associated with sounds they hear every day which stimulate the mental imagination, lets them develop new thoughts and lets them create stories in their minds (Salmon 2010, 937). Music-based rituals and musical games between small children and their caregivers prove to be important for building supportive and social bonds. They also foster the linguistic and cognitive development of young children (Charissi & Rinta 2014, 41). Rattles tied on babies' ankles and wrists give pleasant sounds to the child and should therefore encourage them to move their legs to start walking earlier as well as to move their arms to listen to the sounds (Forchu 2017, 127). But if the Avars were aware of these effects on child development, we must wonder why only a few children possessed metallic idiophones.



Fig. 17.: Child with pellet bell fastened on the wrist (graphic: B. M. Pomberger).

17. ábra: Gyermek csuklójára erősített csörgővel (rajz: B. M. Pomberger)

Ornaments and jewellery

Surely some tiny bells were jewellery. The gold and silver sheet bells from the Kiskőrös graves were worn as pendants, either on a necklace, like in the girl's grave 8, from which we know the find position (László 1955, 28–29) or on earrings like gold finds from an unknown site in the collection of the Hungarian National Museum (Garam 1993, 73–74, pl. 38/1,2). We cannot exclude that pellet bells were used as sounding jewellery for attracting attention. For example, smaller pellet bells from Carantania, the Carolingian-Slavic Period Empire in Carinthia, Austria, probably were sewn on triple caps, like the one shown on a disc fibula from Bled, Slovenia (Eichert 2010, 109–111). Pellet bells and bells tied on belts, ribbons, sleeves and around the wrist (Pomberger et al. in print_a) are jingling and tinkling with nearly every movement. Later, during the Medieval and the Late Middle Ages, pellet bells and bells were beloved accessories of the aristocrats on belts, bandoleers, neck décolletages and jelly bag caps (Lenning 1982, 82–83, fig. 56). Later the middle classes followed them suite and finally degenerate to the burlesque fools' outfit.

Attribute of animistic-religious world view and of popular belief?

Little is known about religious believes in the Avar Khaganate. Evidence of religious world views in terms of shamanism, in some sites of Christianity and acceptance of religious differences among Avar subject peoples are traced by Walter Pohl (Pohl 2018, 254–262).

People attribute different forces/powers to different materials, e.g., such as metals (and stones) (Bächtold-Stäubli & Hoffmann-Krayer 1987, Vol. 2, 717–731; Vol. 5, 414, 576–578, 836–838; Vol. 7, 135, 627, 787, 916). Several points of views still circulate in today's esoteric circles. Early Middle Age bronze, silver, leather and wood capsules in Pannonia and Transylvania with different contents

show non-Christian and Christian motives. They are often interpreted as amulets with both animistic-religious-magical and Christian protective properties (Vida & Fodor 2013). In folk medicine bells and pellet bells are believed to banish demons and operate not only through their material and sound but also through themselves and their single parts (Bächtold-Stäubli & Hoffmann-Krayer 1987, Vol. 3, 868–875). One of Diego Velásquez pictures shows the Spanish Infant Philipp Prosper in a girl's dress. The sickish child is adorned with amulets and a small bell (Wolf 2015, 73–74). Sounding amulets should have a suggestive effect on the wearer and induce them to believe that he is immune to harm (Roberts 1993, 50). Various shaman costumes of the Mongols (Anawalt 2007, 128) and the Ewenki, Daur, Manjagir, Nanay, Tuva, Buryati in East Siberia are decorated with bells and metallic plates. They have a symbolic and spiritual meaning and their ringing is believed to connect unseen and seen sphere: "... The ringing of the bells, a *kam* told Potanin, is the voice of the seven maidens whose symbols are sewed to the collar calling to the spirits to descend to them..." (see tigerbells.nl, also Eliade 1972, 153). Bells and pellet bells in shaman burials should "... invoke the shaman's helper spirits in order to help the deceased in their journey to the other world..." (Hasanov 2016, 202). Bells found in non-shaman Avar burials were probably deposited by a shaman in a view to help the deceased in his journey to the other world, to invoke helper spirits and ward off evil spirits (Hasanov 2016, 207). We suggest that the three bells in the left upper corner of the man's grave A-471 in the Kölked-Feketekapu A cemetery and the five bells of the little girl, grave 157 of Vösendorf, Laxenburgerstraße were such helpful grave goods. Seen across all periods we must state that there are relatively few graves with bells or pellet bells in the Avar Khaganate (Pomberger & Stadler 2018a; Pomberger & Stadler 2018b). Could it be an option to say that mostly only deceased relatives of a shaman or a shamaness were equipped with or wore sounding idiophones?

Summary

The Great Migration Period collection of the Hungarian National Museum houses more than 67 pellet bells and bells from the Avar Period, which are part of the research project '*Metallic Idiophones between 800 BC and 800 AD in Central Europe*'. They stem from 17 sites: Cíkó, Gerjen, Halimba-Belátó-domb, Jánoshida, Jászalsószentgyörgy, Kiskőrös-Vágóhídi-dűlő, Kölked-Feketekapu A, Mosonszentjános-Kavicsbánya, Pilismarót-Óregek-dűlő, Pilismarót-Basaharc, Regöly-Kapuvár, Solymár, Szebény, Szob-Homok-dűlő, Újhartyán, Hungary and Edelstal (Nemesvölgy), Austria. The sites of six pellet bells are unknown. Whereas bells are known from the Early Avar Period, pellet bells

appear at the transition of the Middle Avar Period I to II. Mostly the pellet bells and bells were found direct, near or on the human skeletons. They lay near or under the skull, or near or around the neck, on the chest, near the shoulders, near the elbows, near the forearms and very often near the hands. Another find position is near the pelvis, the knee bends, on the legs, between and near the legs. The bells from the Early Avar Period grave A-471 from Kölked-Feketekapu A lay in the upper left corner of the grave pit. This position is similar to the one of the bells from Late Avar Period grave 157 Vösendorf-Laxenburgerstraße in Lower Austria. Only a third of the idiophones are intact, the rest is fragmented or deformed. All iron idiophones are corroded. Sometimes the rattle bodies – small pebbles, pieces of cinder or small bronze balls – are still inside, lose or corroded on the wall. The bells mostly have no clappers anymore, because forged from iron, they corroded away. Small metal-sheet bells have delicate wire clappers. The sizes of the pellet bells' sound bodies vary from 18 mm up to 34 mm, the bells have sound bodies from 7 mm up to 90 mm.

The basic shapes of the pellet bells are represented by shape I (round-circular), shape II (round-oval) and shape VIII (drop shaped). While cast pellet bells are produced in one-piece, forged pellet bells can be produced from one piece, from two vertical halves or two horizontal halves that are soldered together. Most of the pellet bells have smooth surfaces and no decoration. Only a few pellet bells have ornaments like volutes shaped like a moustache and volutes on the sound slot, scale patterns, vertical grooves and an upside-down T.

The types of the bells cast are represented by type 1, variants A, D and E as well as type 4. Forged bells are represented by the iron bell type 1, variant B, and by type 3.

Chemical analyses were carried out non-destructively by using a handheld XRF. 19 objects made of copper alloy were measured. The analysed metallic idiophones were manufactured from different types of copper alloys: mainly brass, leaded copper, leaded bronze, and one leaded gunmetal and one bronze. The alloy compositions are very heterogeneous. One bell was gilded.

Audio recordings from two bells and six pellet bells have been analysed for their acoustic and psychoacoustic properties using Adobe Audition and HEAD ArtemiSuite. The (pellet) bells spectra range from about 1 kHz all the way up to the upper limit of human hearing, which is about 20 kHz. However, frequencies higher than 10 kHz hardly shape the sound but rather add up to the perception of brightness. Generally, the objects are quite high in sound pressure level (SPL), which is the physical measure for intensity of sound. Corrosion and other

physical destruction greatly dampen the sound emission, the most silent pellet bells (MNM 26.1935.378 and MNM 1964.20.326) hardly even reach 30 dB at a distance of 1 m. The eight recorded pellet bells range from 3–28 sone, which means the louder ones are about 10 times as loud. The brightness (SC) ranges between 3.5–5 kHz could be found for pellet bells and 6–8.8 kHz for the bells, where higher values stand for brighter sounds. With values between 0.02–0.1 asper and 2.5–4.5 acum the eight objects can be described as not rough at all, but quite sharp. Bells with more pronounced partials range between 14–20 dB, the others around 4–8 dB, which is hardly more tonal the noise components.

The textile analyses on the pellet bells offer some possible interpretations on Avar period clothing and other objects in the burial. One remarkably coarse textile on top of a typical Avar period fabric from Kölked-Feketekapu A suggested that the child together with the bell was covered in these layers, which indicates that this pellet bell was not audible if it was worn under these layers in daily life and was perhaps symbolically placed. A fragment of skin on top of a textile and a pellet bell from Halimba-Belátó-domb is quite difficult to interpret, especially considering the position by the neck. A small bag seems possible. Further textile fragments that demonstrate multiple layers indicate pieces of clothing. Yet the fragments do not offer any direct information on how exactly the pellet bells would have been worn in daily life — if they were at all.

The pellet bells could have served as signal instruments against wild animals, probably helped parents to locate their children, maybe served as children' toys. Certainly, the tiny gold sheet bells served as jewellery. But the most plausible explanation of the function of the idiophones is that they served as amulets. A video with the original conserved sounds of the recorded idiophones is available on the internet platform Youtube: "Pellet bells and bells from the Avar Period in the Hungarian National Museum in Budapest" (<https://youtu.be/nrMvHKKIjAM>).

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Catalogue

Legend: th. = total height, hwl. = height without handle, l. = length, w. = width, dm. = diameter, wth. = wall thickness, cw. = conserved weight, InvNr. = inventory number

Literature = Literature used

Locality: Cikó, Tolna County

Site: junction of two valleys, from the bottom to the hill, near railway

Feature function: two cemeteries, one from the early Avar Period and one from the late Avar Period

Date: EAP–LAP, 7th–9th century

Finds: 1 pellet bell, 1 bell

Fig: 18

Literature: Kiss & Somogyi 1984, 62, 67, pl. 33, pl. 43; Szentpéteri 2002, 92–93; Hampel 1905, 306.

cat.1: Bell Inv. Nr.?

Context: burial 499, near the right hand of the skeleton, no further information

Date: LAP?

Conservation status: 90% conserved, clapper inside corroded

Base shape: rectangle

Type: Avar bell-type, type 1/ Var. B

Handle: rectangle

Decoration: none, corroded

Measurements: l.45 mm, w. 25 mm, th. 90 mm

Material: iron

Frequency range: no sound recordings, no frequency analysis

Fig: 18

cat.2: Pellet bell MNM 5.1930.79.

Context: burial 567, woman?

Date: LAP

Conservation status: complete, rattle body lost, simple sound slot, smooth, forged from two halves

Shape: shape II, 2 vertical halves

Handle: rectangle

Decoration: none, smooth

Measurements: dm. 19 x 24 mm, th. 30 mm, hwl. 23 mm, cw. 9 g

Material: leaded copper

Frequency range: no sound recordings, no frequency analysis

Fig: 18

Locality: Edelstal (Nemesvölgy), PB Neusiedl am See, Burgenland, Österreich

Site: Edelstal "Herrschaftsjoch"

Feature function: cemetery

Date: MAP II–LAP, end of 7th–9th century

Finds: 3 pellet bells, one of them is lost

Fig: 19

Literature: Lobinger 2016, 156, 164, 190, pl. 16/10, pl. 56/8.

cat.3: Pellet bell MOS 58.328.9. (Hanság Museum, Mosonmagyaróvár)

Context: burial 21, man, near pelvis of skeleton,

Date: LAP

Conservation status: complete, textile fragments on surface, T-shaped notch

Decoration: none, smooth

Shape: shape II, 2 vertical halves, simple sound slot

Handle: rectangle

Measurements: dm. 27 x 25 mm, th. 38 mm

Material: copper alloy, gilded

Frequency range: no recordings, no frequency analyses

Fig: 19

cat.4: Pellet bell - lost

Context: grave 81, burial of a child

Date: LAP

Conservation status: no further information

cat.5: Pellet bell MNM 69.1891.80.

Context: grave 251, man? no further information

Date: MAP II–LAP I

Conservation status: 2 halves broken and shifted into each other, corroded, rattle body lost,

Decoration: none

Shape: shape I, cruciform sound slot, forged from one piece (?)

Handle: broken

Measurements: dm. 28 x 28 mm, th. 32 mm, wth. 1–2 mm, cw. 8 g

Material: iron

Frequency range: no recordings, no frequency analyses

Fig: 19

Locality: Gerjen, Tolna County

Site: Váradmajor, Váradpuszta, Várad

Feature function: cemetery

Date: LAP, 8th century

Finds: 1 pellet bell

Fig: 18

Literature: Kiss & Somogyi 1984, 109, pl. 48; Szentpéteri 2002, 144.

cat.6: pellet bell (?) MNM 108.1892.495

Context: grave 77, woman, in right hand

Date: LAP, 8th century

Conservation status: fragmented, two horizontal halves, rattle body lost

Decoration: none, smooth surface
 Shape: shape I, sound slot cruciform, four tiny sound holes, forged from 2 horizontal halves
 Handle: turned wire with small loop
 Measurements: dm. 18 mm, h. 14 mm, th. 27 mm, wth. 0.5 mm,
 Material: brass sheet
 Frequency range: no recordings, no frequency analyses
 Fig: 18

Locality: Halimba, Veszprém County

Site: Belátó-domb
 Feature function: cemetery
 Date: MAP–LAP, 7th – 9th century
 Finds: 13 pellet bells, 2 bells
 Figs: 20 and 21
 Literature: Török 1998, 18, 21, 25, 33, 34, 54, 59, pl. 2, 5, 9, 20, 28, 41, 46; Szentpéteri 2002, 157.

cat.7: Pellet bell MNM 63.2.57.

Context: grave 17, woman, below right knee bend
 Date: LAP; 7th – 9th century
 Conservation status: one piece near sound slot broken out, pebble as rattle body
 Decoration: none, smooth, corroded
 Shape: shape II, cruciform sound slot, forged from one piece (?)
 Handle: broken
 Measurements: dm. 28 x 25 mm, th. 30 mm,
 Material: iron
 Frequency range: no recordings, no frequency analyses
 Fig: 20

cat.8: Pellet bell MNM 63.2.58.

Context: grave 17, woman, below right knee bend
 Date: LAP
 Conservation status: two holes in body, handle with wire ring threaded through, pebbles as rattle bodies, textile traces on surface
 Decoration: none smooth, corroded
 Shape: shape II, simple sound slot, forged from two vertical halves
 Handle: round
 Measurements: dm. 29 x 25 mm, cons. h. 33 mm
 Material: iron
 Frequency range: no recordings, no frequency analyses
 Fig: 20

cat.9: Pellet bell MNM 63.2.187

Context: grave 50, child/girl, near left knee
 Date: MAP?
 Conservation status: fragmented, rattle body lost, rattle body, lost

Decoration: none, smooth, corroded
 Shape: shape II, forged from two horizontal halves, simple sound slot
 Handle: lost
 Measurements: dm. 28 mm, cons. h. 28 mm
 Material: iron
 Frequency range: no recordings, no frequency analyses
 Fig: 20

cat.10: Pellet bell MNM 1963.2.359_a

Context: grave 81, child, near the left lower edge of the pelvis, pebble as rattle body
 Date: LAP
 Conservation status: fragmented, one piece broken out, corroded
 Decoration: none, smooth, corroded
 Shape: shape I, cruciform sound slot, forged from one piece
 Handle: broken
 Measurements: dm. 29 mm, cons. h. 30 mm
 Material: iron
 Frequency range: 3.9–8.7 kHz
 Fig: 20

cat.11: Pellet bell MNM 1963.2.359_b

Context: grave 81, child, near the left lower edge of the pelvis, lost
 Date: LAP
 Conservation status: fragmented, one small piece broken out
 Decoration: none, smooth, corroded
 Shape: shape I, cruciform sound slot, forged from one piece
 Handle: broken
 Measurements: dm. 28 mm, cons. h. 28 mm, wth. 1 mm
 Material: iron
 Frequency range: no recordings, no frequency analyses
 Fig: 20

cat.12: Pellet bell MNM 1964.20.326_a

Context: grave 172, child, near left hand
 Date: LAP
 Conservation status: fragmented, rattle body lost,
 Decoration: none, smooth surface, corroded
 Shape: shape I, forged from one piece?
 Handle: broken
 Measurements: dm. 31 mm, cons. h. 32 mm, wth. 1 mm, cw. 7 g
 Material: iron
 Frequency range: no recordings, no frequency analyses
 Fig: 20

cat.13: Pellet bell MNM 1964.20.326_b

Context: grave 172, child, near right hand
 Date: LAP
 Conservation status: nearly complete, filled with material
 Decoration: none, smooth surface, corroded
 Shape: shape I, cruciform sound slot, forged from one piece?
 Handle: broken
 Measurements: dm. 30 mm, cons. h. 32 mm, cw. 19 g
 Material: iron
 Frequency range: no recordings, no frequency analyses
 Fig: 20

cat.14: Pellet bell MNM 1964.20.326_c

Context: grave 172, child, near right hand
 Date: LAP
 Conservation status: corroded, slightly deformed, pebble as rattle body
 Decoration: none, smooth surface, corroded
 Shape: shape I, cruciform sound slot, forged from two vertical halves (?)
 Handle: round-trapezoidal
 Measurements: dm. 31 mm, th. 40 mm, cw. 14 g
 Material: iron
 Frequency range: 1.9 kHz
 Fig: 20

cat.15: Bell MNM 1964.20.327

Context: grave 172, child, on left leg
 Date: LAP
 Conservation status: complete, clapper lost, eyelet conserved inside
 Decoration: Foliage pattern with veined leaves
 Type: Avar bell-type 1/Var. D, hemispherical body
 Handle: broken
 Measurements: dm. 28 mm, cons. h. 16 mm, wth. 1 mm, cw. 16 g
 Material: bronze, gilded
 Frequency range: no recordings, no frequency analyses
 Fig: 20

cat.16: Pellet bell MNM 65.11.237

Context: grave 244, child, near left side of neck
 Date: LAP
 Conservation status: fragmented, three pieces, pebble as rattle body inside corroded, textile rests (?)
 Decoration: none, smooth surface
 Shape: shape I, cruciform sound slot, forged from two vertical halves (?)
 Handle: broken
 Measurements: dm. 26 mm, cons. h. 29 mm, wth. 1 mm

Material: iron

Frequency range: no recordings, no frequency analyses
 Fig: 21

cat.17: Pellet bell MNM 66.20.315

Context: grave 392, woman, near right knee
 Date: MAP (?)
 Conservation status: two pieces fragmented, corroded, pebble as rattle body
 Decoration: no decoration, smooth
 Shape: shape I, two horizontal halves, cruciform sound slot
 Handle: broken
 Measurements: dm. 32 x 32 mm, cons. h. 32 mm, wth. 1 mm
 Material: iron
 Frequency range: no recordings, no frequency analyses
 Fig: 21

cat.18: Pellet bell MNM 66.20.318.a

Context: grave 393, child, between legs
 Date: LAP
 Conservation status: complete with one hole, rattle body inside corroded, handle broken, textile traces on surface
 Decoration: none, surface corroded
 Shape: shape I, sound slot cruciform, f
 Handle: broken
 Measurements: dm. 32 x 32 mm, cons. h. 33 mm, cw. 18 g
 Material: iron
 Frequency range: no recordings, no frequency analyses
 Fig: 21

cat.19: Pellet bell MNM 66.20.318.b

Context: grave 393, child, between legs
 Date: LAP
 Conservation status: deformed, corroded, two vertical halves with two belts? imprints of textiles?
 Decoration: none, surface corroded
 Shape: shape II, sound slot cruciform
 Handle: broken
 Measurements: dm. 32 x 30 mm, cons. h. 35 mm,
 Material: iron
 Frequency range: no recordings, no frequency analyses
 Fig: 21

cat.20: Pellet bell MNM 66.20.526

Context: grave 457, child/girl, near left hand, pebble as rattle body
 Date: LAP
 Conservation status: 40% conserved, corroded

Decoration: none, surface corroded
 Shape: shape I
 Handle: lost
 Measurements: calc. dm. 29 mm, cons. h. 29 mm, wth. 1 mm
 Material: iron
 Frequency range: no recordings, no frequency analyses
 Fig: 21

cat.21: Bell MNM 66.20.527

Context: grave 457, child/girl, near left hand
 Date: LAP
 Conservation status: complete, little bit deformed, wire clapper
 Decoration: one circular groove, surface smooth
 Type: Avar bell-type 1/var. D
 Handle: loop
 Measurements: dm. 25 mm, hwl. 11 mm, th. 23 mm, wth. 1 mm, cw. 5 g
 Material: copper alloy-sheet
 Frequency range: no recordings, no frequency ranges
 Fig: 21

Locality: Jánoshida, Jász-Nagykun-Szolnok County

Site: Tótképuszta, Berkó J. tanya (Gehöft)/at the end of the village, at János Berkó 163
 Feature function: cemetery
 Date: MAP-LAP, 7th-8th century
 Finds: 3 pellet bells
 Fig: 22
 Literature: Erdélyi 1958, 18, 21-22, 39, pl. 20, 23, 39; Szentpéteri 2002, 212.

cat.22: Pellet bell MNM 60.9.14

Context: grave 79, near skull, child?
 Date: LAP
 Conservation status: three fragments (?), 50% conserved, two bronze balls (dm. 9 mm) as rattle bodies
 Decoration: none, smooth surface
 Shape: shape I, two vertical halves
 Handle: lost
 Measurements: dm. 20 mm, h. 20 mm
 Material: leaded copper sheet, gilded
 Frequency range: no recording, no frequency analyses
 Fig: 22

cat.23: Pellet bell MNM 60.9.14

Context: grave 107, child, no further information
 Date: LAP
 Conservation status: complete, rattle body inside
 Decoration: faces with moustache on both sides

Shape: shape I, simple sound slot
 Handle: rectangle
 Measurements: no information
 Material: copper alloy
 Frequency range: no recording, no frequency analyses
 Fig: 22

cat.24: pellet bell MNM 11.1934.26

Context: grave 230, child, in the middle of the grave
 Date: LAP?
 Conservation status: deformed, sound body complete, corroded, rattle body corroded inside
 Decoration: none, surface corroded
 Shape: shape II, forged from two vertical halves
 Handle: broken
 Measurements: dm. 30 x 24 mm, hwl. 32 mm, cons. h. 37 mm, cw. 12 g
 Material: iron
 Frequency range: no recording, no frequency analyses
 Fig: 22

Locality: Jászsószyentgyörgy, Jász-Nagykun-Szolnok County

Site: 'farm building of Mihály Gajdos'
 Feature function: cemetery
 Date: Avar Period, no exact dating
 Finds: 1 pellet bell
 Fig: 18
 Literature: Madaras 1995b, 83; Szentpéteri 2002, 173.

cat.25: pellet bell MNM 11.1935.1

Context: grave, no further information
 Date: MAP-LAP
 Conservation status: 50% conserved, rattle body lost
 Decoration: smooth surface
 Shape: shape I, forged from two horizontal halves
 Handle: broken
 Measurements: dm. 32 mm, cons. h. 22 mm, wth. 1 mm, cw. 13 g
 Material: copper alloy sheet?
 Frequency range: no recording, no frequency analyses
 Fig: 18

Locality: Kiskőrös, Bács-Kiskun County

Site: Vágóhídi-dűlő
 Feature function: cemetery
 Date: MAP-LAP
 Finds: 1 pellet bell. 15 tiny bells
 Fig: 23

Literature: László 1955, 25, 28, 29, 31–34, 36, pl. 6, 9, 13, 14, 20; Garam 1993, 82–83, 85–86, pl. 48, 50, 51, 52; Szentpéteri 2002, 197–198.

cat.26: Pellet bell MNM 4.1935.38

Context: grave 34 (on the find sheet of the pellet bell grave 30 and not grave 34 is noted), child, near right leg on the outer side

Date: LAP

Conservation status: nearly complete, one hole, pebble as rattle body

Decoration: smooth surface

Shape: shape 1, sound slot cruciform

Handle: rectangle shaped

Measurements: 27 x 26 mm, hwl. 27.5 mm. th. 32 mm, with. 1 mm, cw. 24 g

Material: leaded copper sheet

Frequency range: 1.9–9 kHz

Fig: 23

cat.27: 4 tiny bells MNM 18/1934.6

Context: grave 3, human with horse (?), disturbed

Date: LAP I, last third of 7th century – beginning 8th century AD

Conservation status: complete mantles, 1 bell with a wire clapper

Decoration: circular horizontal ridges on mantle, vertical ridges on the mouth

Handle: made of wire

Type: truncated cone with clapper made of bronze wire

Measurements: dm. 8 mm, hwl. 19 mm, th. 27 mm, cw. 3.58 g (4 pieces)

Material: gold sheet

Frequency range: no recordings, no frequency analyses

Fig: 23

cat.28: 6 tiny bells MNM 12/1935.9.

Context: grave 8 (A), child/girl, necklace

Date: LAP I, last third of 7th century – beginning 8th century AD

Conservation status: complete mantles,

Decoration: circular horizontal ridges on mantle, vertical ridges on the mouth

Handle: wire loop

Type: truncated cone with clapper made of wire

Measurements: dm. 7 mm, hwl. 14 mm, th. 18–20 mm, 4.31 g (6 pieces)

Material: gold sheet

Frequency range: no recordings, no frequency analyses

Fig: 23

cat.29: 2 tiny bells MNM 4/1935.24.

Context: grave 17, completely disturbed

Date: LAP I, last third of 7th century – beginning 8th century AD

Conservation status: complete mantles

Decoration: smooth surface

Handle: wire loop

Type: truncated cone Measurements: dm. 5 mm, hwl. 14–15 mm, th. 16 mm, cw. 0.83 g (2 pieces)

Material: gold sheet

Frequency range: no recordings, no frequency analyses

Fig: 23

cat.30: 2 tiny bells MNM 4/1935.59.

Context: grave 41, man, adult, no further information

Date: LAP I, last third of 7th century – beginning 8th century AD

Conservation status: complete mantles

Decoration: circular horizontal ridges

Handle: wire loop

Type: truncated cone with clapper made of bronze wire

Measurements: dm. 5–7 mm, hwl. 8 mm, th. 11 mm, cw. 0.54 g (2 pieces)

Material: gold sheet

Frequency range: no recordings, no frequency analyses

Fig: 23

cat.31: 1 tiny bell MNM 17/1938.34/a.

Context: grave 67, child, near chin

Date: LAP I, last third of 7th century AD

Conservation status: complete mantles, wire clapper?

Decoration: circular horizontal ridges on mantle, vertical ridges on the mouth

Handle: wire loop

Type: truncated cone with clapper made of bronze wire

Measurements: dm. 6 mm, hwl. 14 mm, th. 17 mm

Material: gold sheet

Frequency range: no recordings, no frequency analyses

Fig: 23

Locality: Kölked, Baranya County

Site: Kölked-Feketekapu A

Feature function: 2 cemeteries

Date: EAP–MAP; LAP

Finds: 1 pellet bell, 5 bells

Fig: 24

Literature: Kiss 1996, 23, 38, 51, 52, 95, 126–127, 268, pl. 14, 20, 32, 40, 41, 84; Szentpéteri 2002, 212.

cat.32: bell Inv. Nr.?

Context: grave A-12, woman, filling of grave
 Date: EAP; 6th/7th century AD
 Conservation status: mantle complete, clapper and handle lost
 Decoration: four circles, circular groove
 Handle: lost
 Type: Avar bell-type type 1/var D
 Measurements: dm. 28 mm, h. 7 mm
 Material: copper alloy?
 Frequency range: no recordings, no frequency ranges
 Fig: 24

cat.33: bell Inv. Nr.?

Context: grave A-91, adult, near left forearm
 Date: EAP, 6th/7th century AD
 Conservation status: complete, clapper?
 Decoration: no decoration
 Handle: round
 Type: Avar bell-type 4
 Measurements: dm. mouth 20 mm, dm. middle 12 mm, hwl. 20 mm, th. 30 mm
 Material: copper alloy
 Frequency range: no recordings, no frequency ranges
 Fig: 24

cat.34: bell Inv. Nr.?

Context: grave A-139, child, infans II, near legs
 Date: EAP, 6th/7th century AD
 Conservation status: deformed, clapper made of two chain links
 Decoration: circular groove
 Handle: trapezoidal
 Type: Avar bell-type 1/var. E
 Measurements: dm. 20 mm, hwl. 14 mm, th. 24 mm
 Material: copper alloy
 Frequency range: no recordings, no frequency ranges
 Fig: 24

cat.35: bell, Inv. Nr.?

Context: grave A-144, child/girl, infans I, under the right side of the skull
 Date: EAP, 6th/7th century AD
 Conservation status: deformed mantle with four holes, clapper lost,
 Decoration: no decoration
 Handle: semi-circular
 Type: Avar bell-type 1/var. A
 Measurements: dm. 26 x 22 mm, hwl. 15 mm, th. 18 mm
 Material: copper alloy sheet
 Frequency range: no recordings, no frequency ranges
 Fig: 24

cat.36: bell, Inv. Nr. ?

Context: A-grave 471, man, in the upper left corner of the grave
 Date: EAP, 6th/7th century AD
 Conservation status: mantle complete, handle broken, clapper lost or corroded?
 Decoration: no decoration
 Handle: broken/corroded
 Type: Iron bells, type III
 Measurements: 1.76 x 64 mm, hwl. 85 mm, cons. h. 93 mm
 Material: iron sheet
 Frequency range: no recordings, no frequency ranges
 Fig: 24

cat.37: bell Inv. Nr. ?

Context: grave A-471, man, in the upper left corner of the tomb
 Date: EAP, 6th/7th century AD
 Conservation status: fragmented, deformed, fragments of clapper?
 Decoration: no decoration
 Handle: lost
 Type: Iron bells, type 1/Var. B
 Measurements: dm. 76 x 42 mm, cons. h. 140 mm
 Material: iron sheet
 Frequency range: no recordings, no frequency ranges
 Fig: 24

cat.38: bell Inv. Nr. ?

Context: grave A-471, man, in the upper left corner of the tomb
 Date: EAP, 6th/7th century AD
 Conservation status: slightly deformed mantle complete, clapper lost
 Decoration: no decoration
 Handle: strap handle
 Type: Iron bells, type 1/Var. B
 Measurements: 1.64 mm, w. 40 mm, hwl. 90 mm, th. 110 mm
 Material: iron sheet
 Frequency range: no recordings, no frequency ranges
 Fig: 24

cat.39: Pellet bell MNM 76.1.342

Context: grave A-342, child/boy (?), infans I, near right pelvis
 Date: LAP
 Conservation status: 40% conserved, corroded, textile traces
 Decoration: corroded
 Shape: shape II, two vertical halves
 Handle: rectangle-round shaped
 Measurements: dm. 27 x 21 mm, cons. h. 27 mm,

Material: iron
 Frequency range: no recordings, no frequency analyses
 Fig: 24

Locality: Mosonszentjános, Győr-Moson-Sopron County

Site: Mosonszentjános - Kavicsbánya (Kiesgrube)
 Feature function: cemetery
 Date: LAP
 Finds: 1 pellet bell
 Fig: 18
 Literature: Fettich 1927, 166–171; Szentpéteri 2002, 247.

cat.40: Pellet bell MNM 3.1927.20

Context: grave 4, child? no exact information,
 Date: LAP
 Conservation status: deformed, complete, rattle body lost,
 Decoration: none, corroded
 Shape: shape II, two belts, forged from two vertical halves
 Handle: broken
 Measurements: dm. 18 x 24 mm, hwl. 22 mm, h. 25 mm
 Material: iron
 Frequency range: no recordings, no frequency ranges
 Fig: 18

Locality: Pilismarót, Komárom-Esztergom County

Site: Öregek-dűlő
 Feature function: cemetery
 Date: LAP, last third 7th century – 8th century AD
 Finds: 1 pellet bell
 Fig: 25
 Literature: Szabó 1975, 257, figs. 6 and 12; Szentpéteri 2002, 290.

cat.41: pellet bell MNM 7.941.32

Context: grave 52, child, near right femur
 Date: LAP
 Conservation status: complete, corroded, traces of textiles, pebble as rattle body?
 Decoration: none, smooth surface, corroded
 Shape: shape I, forged from two vertical halves or one piece (?)
 Handle: round
 Measurements: dm. 30 mm, hwl. 30 mm, th. 42 mm
 Material: iron sheet
 Frequency range: no recordings, no frequency ranges
 Fig: 25

Locality: Pilismarót, Komárom-Esztergom County

Site: Pilismarót-Basaharc
 Feature function: cemetery
 Date: LAP
 Finds: 7 pellet bells, 3 bells
 Fig: 26
 Literature: Fettich 1965, 12, 40, 71–74, 82, 88, figs. 1, 3, 59, 61, 122, 123, 124, 126, 138, 142, 147; Szentpéteri 2002, 289

cat.42: bell MNM 69.4.10

Context: grave 4, child, infans I, in the right hand
 Date: LAP III
 Conservation status: sound body, complete, handle lost, clapper fragments inside
 Decoration: none, surface corroded
 Handle: lost
 Type: iron Avar bell-type 1/var. B
 Measurements: 1.32 mm, w. 31 mm, hwl. 44 mm, wth. 2 mm, cw. 20 g
 Material: supposed iron sheet with a cover of copper alloy
 Frequency range: no recordings, no frequency analyses
 Fig: 26

cat.43: bell MNM 4.1941.4

Context: grave? near a child skeleton, buried with the mother
 Date: LAP III
 Conservation status: sound body complete, clapper corroded
 Decoration: smooth surface
 Handle: rectangle
 Type: Avar bell-type 1/var. A
 Measurements: dm. 38 x 39 mm, hwl. 28 mm, th. 37 mm, wth. 1 mm, cw. 37 g
 Material: leaded bronze
 Frequency range: 2.6–20 kHz
 Fig: 26

cat.44: pellet bell Inv. Nr. - no information

Context: grave 86, child, infans I, near left femur
 Date: LAP
 Conservation status: no information
 Decoration: no information
 Shape: no information
 Handle: no information
 Measurements: no information
 Material: iron sheet
 Frequency range: no recordings, no frequency analyses
 Fig: 26

cat.45: pellet bell Inv. Nr. - no information

Context: grave 211, child, infans I, near left hand
 Date: LAP
 Conservation status: fragmented, rattle body lost
 Decoration: smooth surface
 Shape: two horizontal halves
 Handle: lost
 Measurements: no information
 Material: copper alloy - sheet?
 Frequency range: no recordings, no frequency analyses
 Fig: 26

cat.46: pellet bell Inv. Nr. - no information

Context: grave 211, child, infans I, near left hand
 Date: LAP
 Conservation status: fragmented, rattle body lost
 Decoration: smooth surface
 Shape: two horizontal halves?
 Handle: lost
 Measurements: no information
 Material: copper alloy-sheet?
 Frequency range: no recordings, no frequency ranges
 Fig: 26

cat.47: pellet bell Inv. Nr. - no information

Context: grave 217, man, near right elbow
 Date: LAP
 Conservation status: fragmented, rattle body lost
 Decoration: no decoration, corroded
 Shape: no information
 Handle: lost
 Measurements: no information
 Material: iron sheet
 Frequency range: no recordings, no frequency analyses
 Fig: 26

cat.48: pellet bell Inv. Nr. - no information

Context: grave 220, child, infans II, near left shoulder
 Date: LAP
 Conservation status: complete
 Decoration: smooth surface
 Shape: shape I
 Handle: rectangle
 Measurements: no information
 Material: copper alloy
 Frequency range: no recordings, no frequency analyses
 Fig: 26

cat.49: pellet bell Inv. Nr. - no information

Context: grave 241, child, infans I, near head of right femur

Date: LAP

Conservation status: fragmented, rattle body lost
 Decoration: smooth surface, corroded
 Shape: shape II? Two horizontal halves
 Handle: lost
 Measurements: no information
 Material: iron sheet
 Frequency range: no recordings, no frequency analyses
 Fig: 26

cat.50: bell - lost

Context: grave 256, child/girl, infans I, on necklace around neck
 Date: LAP
 Conservation status: not conserved - lost
 Decoration: no information
 Handle: no information
 Type: no information
 Measurements: no information
 Material: copper alloy
 Frequency range: no recordings, no frequency analyses
 Fig: 26

cat.51: pellet bell - lost

Context: grave 257, child, infans I, near right leg
 Date: LAP
 Conservation status: not conserved - lost
 Decoration: no information
 Shape: no information
 Handle: no information
 Measurements: no information
 Material: iron sheet
 Frequency range: no recordings, no frequency analyses
 Fig: 26

Locality: Regöly-Kapuvár, Tolna County

Site: Bozót-dűlő
 Feature function: cemetery
 Date: LAP?
 Finds: 1 small bell
 Fig: 18
 Literature: Kiss & Somogyi 1984, 128, pl. 51; Szentpéteri 2002, 303.

cat.52: bell 91.1892.130.

Context: grave C (A-1), woman? no further information
 Date: EAP-LAP, first half of 7th century – 9th century AD
 Conservation status: complete, one crack, deformed, clapper lost
 Decoration: no decoration, smooth surface
 Handle: round

Type: hemispherical, type 1/Var. A; Avar bells
 Measurements: dm. 30 mm, hwl. 15 mm, th. 22 mm, wth. 0.5 mm, cw. 6 g
 Material: brass
 Frequency range: 3.3–10.7 kHz
 Fig: 18

Locality: Solymár, Pest County

Site: near Dinnye-hegy, téglagyár
 Feature function: cemetery
 Date: EAP–LAP
 Finds: 1 bell, 1 pellet bell
 Fig: 18
 Literature: Török 1994, 12, pl. 14; Szentpéteri 2002, 320–321.

cat.53: pellet bell MNM 72.3.147

Context: grave 32. Child/girl, infans II, between pelvis and femur
 Date: LAP
 Conservation status: complete
 Decoration: no decoration, smooth
 Shape: shape II, sound slot cruciform
 Handle: rectangular-round
 Measurements: dm. 30 x 32 mm, hwl. 34 mm, th. 45 mm
 Material: leaded copper
 Frequency range: 1.1–13 kHz
 Fig: 18

cat.54: bell no information

Context: grave 32, child/girl, infans II, between pelvis and femur,
 Date: LAP
 Conservation status: 60% conserved, corroded, clapper lost,
 Decoration: no decoration, smooth
 Shape: Avar iron bell-type 1/var. B
 Handle: no information
 Measurements: no information
 Material: iron
 Frequency range: no recordings, no frequency analyses
 Fig: 18

Locality: Szébény, Baranya County

Site: Szébény Cemetery I
 Feature function: cemetery
 Date: MAP–LAP
 Finds: 1 bell, 3 pellet bells
 Fig: 27
 Literature: Garam 1975, 77, 84, 86, 88, figs. 4, 14, 17, 19; Szentpéteri 2002, 339.

cat.55: pellet bell 2.1936.85

Context: grave 30, child/infans I, on right side of pelvis
 Date: LAP
 Conservation status: complete, rattle body lost
 Decoration: vertical grooves
 Shape: shape VIII, three sound holes, two of them rectangular, one circular
 Handle: round
 Measurements: dm. 21 mm, th. 35 mm, cw. 12 g
 Material: gunmetal
 Frequency range: no recordings, no frequency ranges
 Fig: 27

cat.56: bell 26.1935.273

Context: grave 183, child/infans I, near the right femur
 Date: MAP–LAP
 Conservation status: one halve conserved, corroded
 Decoration: no decoration, corroded
 Handle: round
 Type: type II Avar bells
 Measurements: cons. 1.24 mm, cons. h. 58 mm, wth. 1–2 mm, cw. 19 g
 Material: iron
 Frequency range: no recordings, no frequency ranges
 Fig: 27

cat.57: pellet bell 26.1935.378

Context: grave 228, child/infans I, near left side of head (?)
 Date: LAP
 Conservation status: 90% conserved, cruciform sound slot, handle broken, cinder as rattle body
 Decoration: small volute like a moustache
 Shape: shape II
 Handle: rectangular
 Measurements: dm. 18 x 21 mm, hwl. 18 mm, th. 26 mm, cw. 11 g
 Material: leaded bronze
 Frequency range: 4.2 kHz
 Fig: 27

cat.58: pellet bell 26.1935.446

Context: grave 276, child/infans I, no further information
 Date: LAP
 Conservation status: 40% conserved, deformed
 Decoration: no decoration, smooth
 Shape: shape II
 Handle: round-trapezoidal
 Measurements: dm. 24 x 22 mm, hwl. 24 mm, th. 31 mm, wth. 0.5 mm
 Material: leaded bronze sheet

Frequency range: no recordings, no frequency ranges
Fig: 27

Locality: Szob, Pest County

Site: Homok-dűlő
Feature function: cemetery
Date: LAP
Finds: 2 pellet bells
Fig: 28
Literature: Kovrig 1975, 179, 181, figs. 9, 11; Szentpéteri 2002, 362.

cat.59: pellet bell MNM 21.1936.92

Context: grave 85, child/boy, near the pelvis
Date: LAP III
Conservation status: 50% conserved, corroded, rattle body lost, textile rests
Decoration: no decoration, corroded
Shape: shape I
Handle: rectangle
Measurements: dm. 26 mm, hwl. 28 mm, th. 36 mm
Material: iron
Frequency range: no recordings, no frequency ranges
Fig: 28

cat.60: pellet bell MNM 21.1936.148

Context: grave 99, child/boy, near the right hand
Date: LAP
Conservation status: 40% conserved, corroded, rattle body lost? textile rests
Decoration: no decoration, corroded
Shape: shape II
Handle: round
Measurements: 15 x 23 mm, hwl. 27 mm
Material: iron
Frequency range: no recordings, no frequency ranges
Fig: 28

Locality: Újhartyán, Pest County

Site: no information
Feature function: cemetery
Date: LAP?
Finds: 1 pellet bell
Fig: 18
Literature: unpublished; Szentpéteri 2002, 394.

cat.61: pellet bell MNM 34.1923.2

Context: no information
Function of features: no information
Date: MAP-LAP?
Conservation status: complete, rattle body lost
Decoration: no decoration, smooth

Shape: shape I, simple sound slot
Handle: rectangular
Measurements: dm. 27 mm, hwl. 27 mm, th. 39 mm
Material: leaded bronze
Frequency range: no recordings, no frequency ranges
Fig: 18

Pellet bells from unknown sites

cat.62: pellet bell MNM 14.1952.4

Context: no information
Function of features: no information
Date: MAP-LAP?
Conservation status: 60% conserved, rattle body lost
Decoration: no decoration, smooth, one horizontal belt
Shape: shape II, simple sound slot, 2 sound holes
Handle: round
Measurements: dm. 36 x 43 mm, hwl. 32 mm, th. 46 mm, cons.w. 39 g
Material: copper alloy
Frequency range: no recordings, no frequency analyses
Fig: 29

cat.63: pellet bell MNM 46.1878.30

Context: no information
Function of features: no information
Date: MAP-LAP
Conservation status: 50% conserved, rattle body lost
Decoration: scale patterns
Shape: shape I, 2 sound holes on upper part,
Handle: rectangular
Measurements: dm. 26 mm, cons. h. 28 mm, wth. 1 mm, cons. w. 25 g
Material: copper alloy
Frequency range: no recordings, no frequency analyses
Fig: 29

cat.64: pellet bell MNM 50.1891.102

Context: no information
Function of features: no information
Date: MAP-LAP
Conservation status: 90% conserved, 2 small holes, rattle body lost
Decoration: no decoration
Shape: shape II, simple sound slot
Handle: rectangular
Measurements: dm. 25 x 27 mm, hwl. 25 mm, th. 37 mm, cons. w. 20 g
Material: copper alloy

Frequency range: no recordings, no frequency analyses
Fig: 29

cat.65: pellet bell MNM 62.149.9

Context: no information
Function of features: no information
Date: MAP-LAP
Conservation status: complete, pebble as rattle body
Decoration: scale patterns
Shape: shape I, 4 sound holes, simple sound slot
Handle: rectangular
Measurements: dm. 29 mm, hwl. 28 mm, th. 36 mm, wth. 1–2 mm, cons. w. 27 g
Material: copper alloy
Frequency range: 2.3–9.7 kHz
Fig: 29

cat.66: pellet bell MNM 54.1950.13

Context: no information
Function of features: no information
Date: MAP-LAP
Conservation status: complete, rattle body lost
Decoration: no decoration, smooth

Shape: shape I, 4 sound holes, cruciform sound slot
Handle: round Measurements: dm. 27 mm, hwl. 27 mm, th. 33 mm, wth. 2–3 mm, cons. w. 28 g
Material: copper alloy
Frequency range: no recordings, no frequency analyses
Fig: 29

cat.67: pellet bell MNM 1961.82.1

Context: no information
Function of features: no information
Date: MAP-LAP
Conservation status: 75% conserved, rattle body lost
Decoration: scale pattern
Shape: shape I, 4 sound holes, simple sound slot
Handle: rectangular
Measurements: dm. 36 mm, hwl. 36 mm, th. 44 mm, wth. 1 mm, cons. w. 35 g
Material: copper alloy
Frequency range: no recordings, no frequency analyses
Fig: 29

