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# FROM SEED TO BREAD. WAS *PANIS ROMAE* LIKE OUR BREAD?

LÁSZLÓ SZEKERNYÉS\* – SZILAMÉR-PÉTER PÁNCZÉL\*\*

*The aim of this paper is to analyse some aspects of the milling process, the fineness of the flour, the quality of bread and bakery products from the Roman age. By means of archaeological experiments we have analysed the practical aspects of the 'chaîne opératoire', such as productivity of the mill, quality of the grist and bread making.*

**Keywords:** legionary mill, flour, Roman bread, wheat, sieve

**Cuvinte-cheie:** râșniță, făină, pâine romană, grâu, sită

Cereal consumption was part of the daily diet in the Roman Empire. The process of milling cereals in order to produce flour and bakery products was not only a large scale industry, but also a domestic activity.<sup>1</sup> The spread of the rotary quern, the *mola hispanensis* or *mola versatiles*, at the end of the Roman Republic, greatly facilitated the process of milling grain.<sup>2</sup> The evolution of the *mola hispanensis*, into the Roman *mola legionaria*<sup>3</sup> was the ultimate advancement. We also have archaeological evidence and ancient sources on the existence of different flour types and bakery products.

The main question is whether Roman technology can produce suitable bakery products that meet our modern standards. Therefore, we reproduced the milling, sieving, and baking processes using cereal species known in the Roman age. Our aim was also to compare the Roman *mola legionaria* to the Egyptian saddle quern and to modern hand mills.

For the milling experiment we used the following six grain types known by the Romans,<sup>4</sup>

each weighing 500g (roughly 1 *sextarii*), necessary to make one Roman bread:<sup>5</sup>

1. Common wheat (*Triticum aestivum*) known as bread wheat or winter wheat, *siligo*,<sup>6</sup> largely used in the Empire for making white bread, *panis siligneus* and quality pastry products.



Fig. 1. The *mola legionaria* reconstruction.

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<sup>1</sup> VERGILIUS, *Moretum*.

<sup>2</sup> For the terminology see also: SZEKERNYÉS–PÁNCZÉL 2022, 143–144.

<sup>3</sup> PEACOCK 2013, 74.

<sup>4</sup> GRÜLL 2013, 4–5.

<sup>5</sup> JUNKELMANN 1997, 136.

<sup>6</sup> PLINIUS, *Nat. Hist.* 18.10.

2. Spelt (*Triticum spelta*) or *arinca*,<sup>7</sup> ancient wheat known today as dinkel wheat or hulled wheat, related to the winter wheat, also largely used.

3. Einkorn (*Triticum monococcum*), related to spelt.

4. Rye (*Secale cereale*), cultivated mostly in the *Barbaricum* in the regions of Europe with a temperate climate, resistant to harsh climatic conditions, and poorer soils. According to Pliny, this is the worst type of grain for bread, and it is only useful to avoid starvation.<sup>8</sup>

5. Barley in hulled form (*Hordeum vulgare*).

6. Millet (*Panicum miliaceum*) mainly used for porridge or as an addition to wheat flour in different bakery products.<sup>9</sup>

These grain types were largely cultivated in Roman times, used in the daily diet and were suitable for various bakery products. It is also important to mention that, they are the same from ancient to modern times in terms of grain hardness and gluten content.

What we know about the grinding process in the Roman Empire, is that two different methods of milling were used. On the one hand, it was done on a large scale with large Pompeiian type mills, watermills and donkey mills. From the Imperial times onwards, this included the

bakers' guild called *corpus pistorum*.<sup>10</sup> The second method was milling with rotary querns, in households for personal consumption. The latter was a common activity in rural households,<sup>11</sup> or a fancy aristocratic habit,<sup>12</sup> and was also used in the army.<sup>13</sup>

For the grinding we used a replica of a *mola legionaria*, used in the 2<sup>nd</sup> century A.D. The replica (Fig. 1) is a copy based on legionary mills discovered at the military site of Călugăreni / Mikháza, located on the eastern *limes* of Roman Dacia.<sup>14</sup>

The measurements refer to the entire grinding process, i.e. loading of the grain, collection of the grist and intermittent re-feeding of the hopper. The experiment contains two sets of grinding.

Firstly, the goal of grinding was the physical process as a daily duty, to obtain a flour to secure the 'iron ration' a *panis militaris*, a low quality whole wheat bread. This was an army bread that a soldier of the *contubernia* may have had to prepare. The verification process of the flour's quality was done superficially only by its physical aspects.

During the experiment (Fig. 2) we examined the following data based on different grain types: 1) grinding speed; 2) number of grind-

Grain type	1) Speed (rotation / min.)	2) No. of grindings / time for groats	3) No. of grindings / time for seconds	4) No. of grindings / time for finest flour
Wheat	40–45	2 / 3'05"	4 / 6'17"	6 / 9'40"
Spelt	40–45	2 / 3'00"	4 / 6'10"	6 / 9'30"
Einkorn	40–45	2 / 2'55"	4 / 6'12"	6 / 9'40"
Rye	40–45	4 / 5'20"	6 / 8'45"	not possible
Barley	40–45	2 / 1'50"	4 / 6'10"	not possible
Millet	40–45	1 / 0'40"	not possible	not possible

Fig. 2. Data collected during the grinding process.

whole process of grinding, sieving, and possibly baking on an industrial scale. It was made by the

ings / grinding time for groats; 3) number of grindings / grinding time to obtain whole wheat

<sup>7</sup> PLINIUS, *Nat. Hist.* 18.10.

<sup>8</sup> PLINIUS, *Nat. Hist.* 18.40.

<sup>9</sup> PLINIUS, *Nat. Hist.* 18.24, 26.

<sup>10</sup> GRÜLL 2013, 29.

<sup>11</sup> VERGILIUS, *Moretum*.

<sup>12</sup> SENECA, *Ep.* 119.

<sup>13</sup> ROTH 1999, 48.

<sup>14</sup> SZEKERNYÉS-PÁNCZÉL 2022.

flour; 4) number of grindings / grinding time to obtain fine flour.

The grinding speed could not be increased, not only because the seeds fall out from the mill due to the centrifugal force, but also because the grist flows quickly from the stones, thus reducing the efficiency. The optimum speed is between 40 rotations per minute (for the first grinding of the whole seeds) and 50 rotations per minute (for the subsequent grindings and the flour phases), regardless of the physical quality of the seed. In order to obtain fine flour, it is recommended not to sieve the grist in the intermediate phases. As a general remark it has to be mentioned, that the use of different groats sizes ensures maximum milling efficiency. Milling with the legionary mill was easy, roughly equivalent to the endurance of a 12–13-year-old child for 10–15 minutes, taking into account the entire interval. The reason for this is that the grain and grist assures a rolling friction and the *catillus* floats on the *meta* during the whole process.

To make *puls*<sup>15</sup> or porridge, we can use any type of grain that can be ground, and it is a quick procedure. Course grinding does not affect the

high fibre and low gluten content. Only wheat grains are suitable to obtain fine flour for white bread, because of their relatively low fibre and high gluten content.

Converting the results to a *contubernium* (group of 8 soldiers), grinding the daily rations of 16 *sextarii* of grain (roughly 8kg), takes around 40–50' for *puls* and 1h40'–1h50' for bread. This is a reasonable estimate for a family of four as well, for a two-day timespan. The experiment of milling the daily ration for a *contubernium* carried out by Jodry on a *mola legionaria*, had a similar efficiency of 1h40' for 6,8kg of grain.<sup>16</sup> Junkelmann obtained an efficiency of 1h40' for 5kg of grain.<sup>17</sup> There are slight differences in the quantities of the daily ration, because we do not know the exact weight of the *frumentum*, only that it was two *sextarii* of grain per soldier in the Imperial times.<sup>18</sup>

According to Delwen's experiments with an Egyptian saddle quern, the milling time does not necessarily depend on the grain hardness, but rather on gluten and fibre content (Fig. 3).<sup>19</sup>

The Roman legionary mill is 4.6–5 times more efficient than the saddle quern in producing semolina and 8.4–9 times more efficient for

Wheat type	Wheat hardness	Time for milling coarse meal (s)	Time for milling fine meal (s)	Time for milling fine meal (s)
Zimmerhackl	very hard	18.3 +/- 1.5	27.7 +/- 2.5	46 +/- 3.5
Duilio	hard	22.3 +/- 2.5	29.3 +/- 2.1	51.7 +/- 3.8
Garfagnana	soft	17 +/- 1.7	23 +/- 3.5	40 +/- 4.6
Centauro	soft	23 +/- 1.7	33.7 +/- 2.5	56.7 +/- 4.2

Fig. 3. Time to grind 10g of wheat with the grinding stone (DELWEN 2010, 473, Table 4).

internal characteristics of the grain, and it is possible to obtain rough flour, or seconds for *panis militaris*, *panis cibarius*, *panis plebeius*, military or ordinary bread. Millet is an exception, producing only fine semolina during the whole grinding process. The reason may be its high fibre content and lack of gluten. Rye also takes longer to grind into wheat because of its

the production of fine flour. The efficiency of the Roman mills is also demonstrated by their longevity. According to Jodry, the hand mills of the French army of the 18–19<sup>th</sup> century had a similar productivity.<sup>20</sup>

As a preliminary conclusion, it is obvious, that the grain processed with Roman legionary mill was suitable for making bread. The main

<sup>15</sup> PLINIUS, *Nat. Hist.* 18. 10.

<sup>16</sup> JODRY 2011a, 73.

<sup>17</sup> JUNKELMANN 1997, 118.

<sup>18</sup> ROTH 1999, 43.

<sup>19</sup> DELWEN 2010.

<sup>20</sup> JODRY 2011b, 85–86.



question is whether the quality of flour and bread could be used to make products according to modern standards. We have reports from ancient texts about grain qualities, flour types, various bread and pastry products and ingredients.<sup>21</sup> We also have archaeological evidence about their aspect and obviously subjective sources about their taste.

To compare the flour obtained and the taste of bakery products with the flour of the modern milling industry and bakery products, we need a different, rather experimental approach.

To reveal some aspects of this issue, we tried to reproduce the whole process from milling to baking according to the Roman sources. In this experiment we did not try to reveal the efficiency, but the quality of the ingredients in comparison with modern techniques.

As a first step, we milled the same quantity of different grain types, focusing only on obtaining the finest flour possible (Fig. 4).

The physical quality of flour depends on the particle size, the finest flour being the best quality. In the Roman era there were two ways to obtain quality flour, either by grinding the grain to the finest size, or/and by sieving it to separate fine flour. The Romans used sieves<sup>22</sup> to obtain fine flour, however we have no information about the sieve size. They probably used crinoline (horsehair) sieve, or linen cloth.<sup>23</sup> For measuring the particle size of the flour, we used sieves with different mesh sizes (Fig. 5). The mesh sizes are in accordance with present-day

Cereal type	Speed (rotation / min.)	No. of grindings / time for finest flour
Common wheat	50–60	7 / 12' 20"
Spelt	50–60	7 / 16' 50"
Einkorn	50–60	5 / 11' 10"
Rye	50–60	7 / 13' 10"
Barley	50–60	7 / 11' 14"
Millet	50–60	5 / 9' 10"

Fig. 4. Data collected during the grinding process to obtain the finest flour.

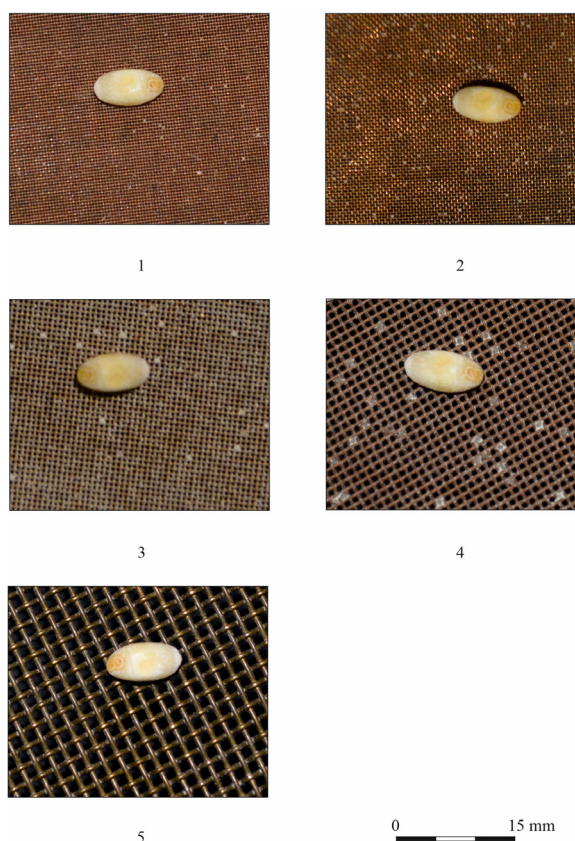


Fig. 5. Modern mesh sizes in the food industry (5/1. 180  $\mu$ m; 5/2. 250  $\mu$ m; 5/3. 315  $\mu$ m; 5/4. 500  $\mu$ m; 5/5. 2000  $\mu$ m).

mill industry standards to obtain different flour categories (Fig. 6).<sup>24</sup>

The purpose of the sieving experiment was to obtain flour for kneaded and leavened bread in a reasonable time, based on visual quality control and tasting experience. Hence, we sieved only at the end of the milling process. We also presume that the sieves used by the Romans were less efficient than modern industrial sieves. If they made flour of modern standard quality, they did it by refilling the intermediary grist. In the light of this, we used modern sieves to compare sieved flour with modern milling products (Fig. 7).

In the sieving experiment we divided the grain types into two categories:

<sup>21</sup> PLINIUS, *Nat. Hist.* 18.10, 20.

<sup>22</sup> VERGILIUS, *Moretum*.

<sup>23</sup> PLINIUS, *Nat. Hist.* 18.28.

<sup>24</sup> MAGYAR ÉLELMISZERKÖNYV 2014, 17–20, 35.

Sieve size / percentage	Particle size				
	'Strudel' flour (BFF 55)	White bread flour (BL 55)	Rough bread flour (BTKL)	Graham bread flour (BGL)	Rye flour (RL)
	360µm/100% 160µm/max. 25%	315µm/min. 100% 250µm/min. 95%	500µm/min. 85% 315µm/min. 70%	>2000µm/100 % 315µm/min. 70%	250µm/min. 100%

Fig. 6. Particle size of different modern flour types (MAGYAR ÉLELMISZERKÖNYV 2014, 6–20).

1. Wheat grain – common wheat, spelt and einkorn.

2. Rye, barley and millet.

There is a difference between the two categories, based on their gluten content. The first is high in gluten and is suitable for leavened bread, the second is low in gluten and is mainly used as admixture in the dough.

In case of the wheat, sizes over 2000µm are accidental bran or grain pieces stuck in the mill. The common wheat flour is the finest, and the

Surprisingly, milling einkorn seems to give similar results as milling common wheat.

Rye and barley, from the second group, seem unsuitable for fine flour with a legionary mill. We know from Pliny<sup>26</sup> and archaeological evidence that Romans and barbarians made porridge or unleavened bread from these grains. By grinding millet, we quickly and easily obtained a very good quality semolina, but it was impossible to obtain fine flour.

To have a general understanding of what

Cereal type	No. of grindings / time for finest flour	Particle size µm %				
		>2000	<500	<315	<250	<180
I. Common wheat	5 / 12'20"	4%	85%	65%	41%	9%
I. Spelt	7 / 16'50"	14%	60%	39%	23%	2%
I. Einkorn	5 / 11'10"	7%	73%	52%	35%	5%
II. Rye	7 / 13'10"	40%	46%	-	-	-
II. Barley	7 / 11'14"	63%	-	-	-	-
II. Millet	5 / 9'10"	3%	87%	31%	3%	-

Fig. 7. Particle sizes after sieving the flour.

results of sieving show that without intermediary sieving we obtain significant quantities of quality flour. This suggests that rough bread (BTKL) or graham bread (BGL) flour was quite common in the Roman times. White bread flour (BL55) requires a process of intermediary bolting, but it was also possible to produce. It is almost impossible to obtain very fine 'strudel' flour (BFF55) in an average domestic grinding process. Pliny mentions a type of very fine flour called *fos* or *pollen*, used in copper works and certain manufactories,<sup>25</sup> that could be a possible equivalent to 'strudel' flour. Spelt is also suitable for the same quality flour as common wheat, the major difference being that it is much more labour intensive to obtain similar products.

bread meant to the Romans, we made baking experiments with the flour varieties to test the possible final products (Fig. 8–9). The purpose was to reproduce the physical properties of the bread variants. The only extra ingredient in the modern version was the yeast. When kneaded, it technically produces the same chemical effect as the Roman dough: it produces carbon dioxide which makes the bread grow. According to Pliny, dough was quite common in Roman times. He mentions four kinds of leaven recipes: made with millet and must, wheat-bran and must, barley and vetch with water, or reused bread dough.<sup>27</sup>

In the recipe we used the obtained flour types, water, salt and yeast, as follows: flour

<sup>25</sup> PLINIUS, *Nat. Hist.* 18.10, 20.

<sup>26</sup> PLINIUS, *Nat. Hist.* 18.13.

<sup>27</sup> PLINIUS, *Nat. Hist.* 18.26.





Fig. 8. The external aspect of the bread variants.

100g, water approx. 70g, yeast 10g and a pinch of salt.

The wheat breads made from fine flour (types 1–3, 9) are just like our modern breads, in every sense of the word. All the organoleptic qualities fit our modern standards. They are edible for several days, even when they dry. Types 4 and 8 are similar in physical aspects and taste to our brown bread. Types 5–7 are similar to the

modern multigrain or fitness type of bread, low leavened even with the use of yeast.

In the Roman age, quality wheat bread was at least as good as our country bread. The Romans had the whole technological chain to make good bread, with a great variety of shapes, baking techniques<sup>28</sup> and ingredients for each taste.<sup>29</sup> The variety of grains and different wheats like *siligo*, *arinca*, *gaulian*, African wheat, Campanian

<sup>28</sup> PLINIUS, *Nat. Hist.* 18.27.

<sup>29</sup> PLINIUS, *Nat. Hist.* 18.27.

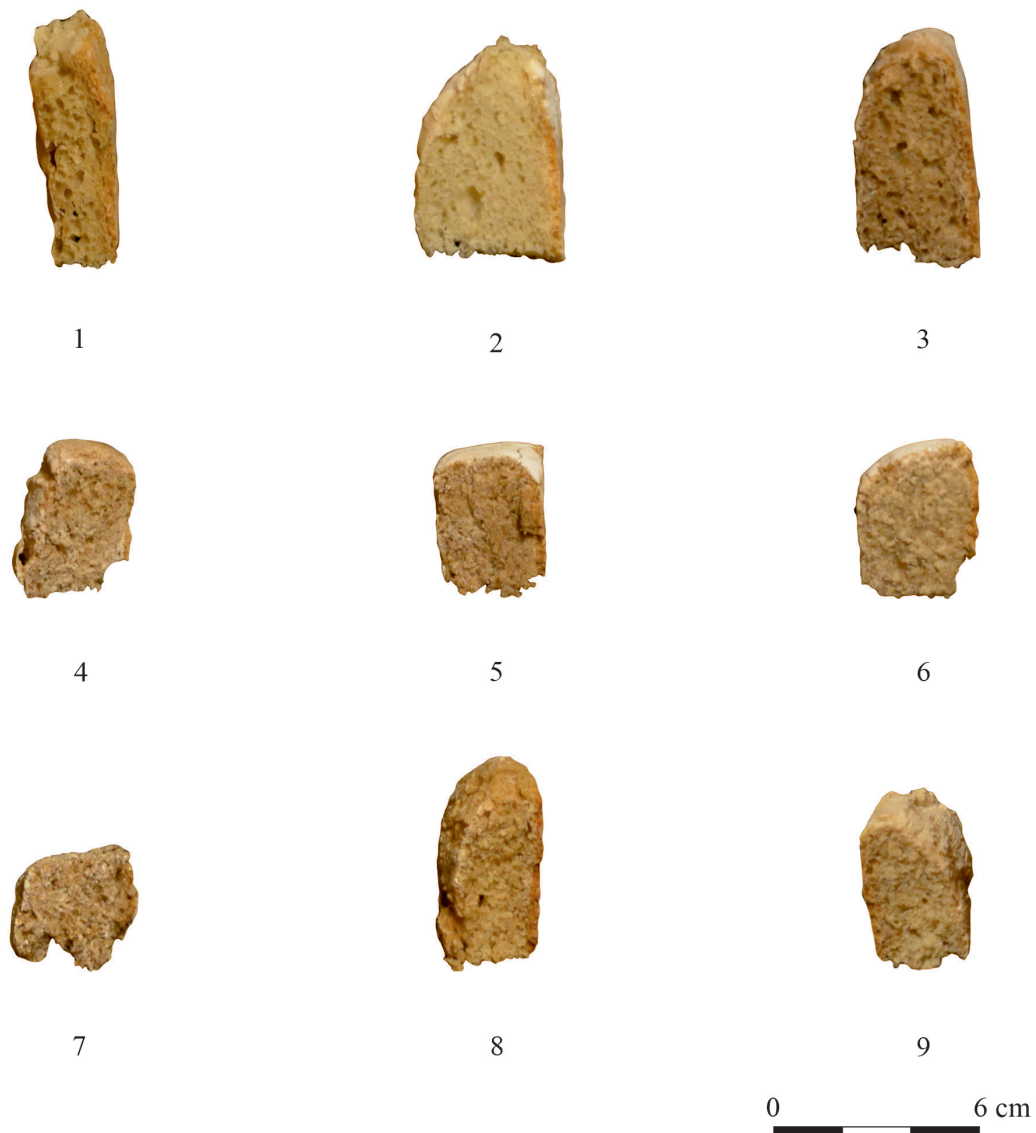


Fig. 9. The internal aspect of the bread variants.

Bread type (Fig. 9–10) based on modern flour types	Dough quality	Bread consistency	Taste
1. Einkorn white bread~ BL55	very soft	well leavened, very soft	very good
2. Common wheat white bread~ BL55	soft	well leavened, soft	very good
3. Spelt white bread~ BL55	medium soft	leavened, soft	good, sweetish
4. Spelt rough bread~ BTKL	medium hard	low leavened, dense, soft	good, sweetish
5. Rye flour (>2000 20%, >500 80%)	very hard	unleavened, dense, short pastry, crumbling	bittersweet
6. Barley flour (>2000)	very hard	low leavened, dense, short pastry, crumbling	acceptable, bittersweet
7. Rye flour (>2000 80%, <2000 20%)	very hard	unleavened, dense, short pastry, crumbling	sour, bittersweet
8. Einkorn rough bread~ BTKL	soft	leavened, soft	good
9. Mix white bread (einkorn 15%, spelt 15%, wheat 70%)	soft	well leavened, soft	very good

Fig. 10. Data collected during the bread baking process.

wheat, Pisan wheat or the ones from Clusium and Arretium<sup>30</sup> had similar features to modern wheat. The milling process made it technically possible to produce fine flour by modern standards, even using legionary mills. Although they did not have the equipment to obtain fine flour with a sieving technology, they replaced this with their milling expertise. Sieves were only used to separate the bran, impurities, and for

additional refinement. There was also a popular belief that leavened wheat bread was healthier.<sup>31</sup> It is also presumable, that not everyone could afford quality wheat bread, and in harsh times the Romans ate whole wheat bread, rye bread, oat bread, or rough bread. During campaigns, soldiers ate what they managed to prepare: *panis militaris* or *bucellatum*.<sup>32</sup>

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<sup>30</sup> PLINIUS, *Nat. Hist.* 18.20.

<sup>31</sup> PLINIUS, *Nat. Hist.* 18.26.

<sup>32</sup> AMMIANUS, *Res Gestae* 17.8.2.

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## ABBREVIATIONS

<i>ActaArchHung</i>	Acta Archaeologica Academiae Scientiarum Hungaricae
<i>ActaMN</i>	Acta Musei Napocensis
<i>Acta MP</i>	Acta Musei Porolissensis
<i>ActaTS</i>	Acta Terrae Septemcastrensis
<i>AIIA</i>	Anuarul Institutului de Istorie și Arheologie “A. D. Xenopol”. Iași
<i>AJA</i>	American Journal of Archaeology
<i>Angustia</i>	Angustia. Muzeul Carpaților Răsăriteni
<i>Apulum</i>	Apulum. Acta Musei Apulensis
<i>ArchÉrt</i>	Archaeologiai Értesítő
<i>ArchKorr</i>	Archäologisches Korrespondenzblatt
<i>ArhMold</i>	Arheologia Moldovei
<i>Banatica</i>	Banatica, Muzeul Banatului Montan
<i>BAR (IS)</i>	British Archaeological Reports (–International Series)
<i>BHAUT</i>	Bibliotheca Historica et Archaeologica Universitatis Timisiensis
<i>BJ</i>	Bonner Jahrbücher
<i>BAI</i>	Bibliotheca Archaeologica Iassiensis
<i>BAM</i>	Bibliotheca Memoriae Antiquitatis
<i>BMA</i>	Bibliotheca Musei Apulensis
<i>BMM</i>	Bibliotheca Musei Marisiensis
<i>BMN</i>	Bibliotheca Musei Napocensis
<i>BMP</i>	Bibliotheca Musei Porolissensis
<i>BudRég</i>	Budapest Régiségei
<i>CA</i>	Cercetări Arheologice
<i>CCAR</i>	Cronica Cercetărilor Arheologice din România
<i>Dacia (N. S.)</i>	Dacia. Recherches et découvertes archéologiques en Roumanie, I–XII (1924–1948), Nouvelle série (N. S.): Dacia. Revue d’archéologie et d’histoire ancienne
<i>DolgKoložsvár (Ú.S.)</i>	Dolgozatok az Erdélyi Nemzeti Múzeum Érem- és Régiségtárából, (Új sorozat 2006–)
<i>EMúz</i>	Erdélyi Múzeum
<i>EphemNap</i>	Ephemeris Napocensis
<i>FolArch</i>	Folia Archaeologica
<i>JAHA</i>	Journal of Ancient History and Archaeology
<i>JbRGZM</i>	Jahrbuch des Römisch-Germanischen Zentralmuseums
<i>JRA</i>	Journal of Roman Archaeology
<i>KuBA</i>	Kölner und Bonner Archaeologica
<i>Lymbus</i>	Lymbus. Magyarságtudományi Forrásközlemények
<i>Marisia</i>	Marisia (V–XXXV): Studii și Materiale
<i>Marisia-AHP</i>	Marisia: Archaeologia, Historia, Patrimonium
<i>MCA</i>	Materiale și Cercetări Arheologice
<i>MFME (–StudArch)</i>	A Móra Ferenc Múzeum Évkönyve, (Studia Archaeologica 1995–)
<i>ReiCretActa</i>	Rei Cretariae Romanae Fautorum Acta

<i>RevBis</i>	Revista Bistriței. Complexul Județean Muzeal Bistrița-Năsăud
<i>Sargetia</i> (S.N.)	Sargetia. Acta Musei Devensis
<i>SCIV</i> (A)	Studii și Cercetări de Istorie Veche (și Arheologie 1974–)
<i>StComSfGheorghe</i>	Studii și comunicări. Sfântu Gheorghe
<i>StudiaAA</i>	Studia Antiqua et Archaeologica. Iași



## MARISIA. ARCHAEOLOGIA, HISTORIA, PATRIMONIUM

With a publishing tradition since 1965, in 2019 the annual of the Mureș County Museum initiated a new series entitled: *Marisia. Archaeologia, Historia, Patrimonium*. The publication provides a panel for new research results in archeology, architecture and material heritage of the history of arts and culture. The studies mainly focus on the inner Transylvanian region that encompasses also Mureș County. Beyond local valuable contributions, the annual aims at a regional and global concern that is relevant for the whole of Transylvania. Among the annual's missions is to provide mutual interpretation of the research results produced by the Romanian and Hungarian scientific workshops. Therefore, the annual articles are mainly in English but based on the field of research and the approached topic studies in German, Romanian or Hungarian are also accepted.

Cu o tradiție din anul 1965, anuarul Muzeului Județean Mureș s-a relansat în 2019 sub titlul *Marisia. Archaeologia, Historia, Patrimonium*. Această publicație se descrie ca o platformă științifică care cuprinde rezultatele cercetărilor în domenii precum: arheologia, arhitectura și patrimoniul material din zona istoriei artelor și a culturii, studii localizate în regiunea centrală a Transilvaniei, din care face parte județul Mureș. In extenso, anuarul își propune să ofere un spațiu unitar contribuțiilor științifice valoroase, relevante din perspectiva geografică a ceea ce înseamnă întreaga regiune a Transilvaniei. Una dintre misiunile publicației este aceea de a oferi tuturor celor interesați spațiul de schimb pentru cele mai noi rezultate din atelierele științifice românești și maghiare. Articolele anuarului sunt scrise în general în limba engleză, existând totodată articole scrise în germană, română și maghiară, în funcție de specificul domeniului și a temei abordate.

A Maros Megyei Múzeum 1965 óta megjelenő évkönyvének 2019-ben útjára bocsátott új sorozata, a *Marisia. Archaeologia, Historia, Patrimonium* elsősorban a mai Maros megyét is magába foglaló belső-erdélyi régió régészeti, épített és tárgyi örökségére, nemkülönben az ezekhez kapcsolódó művészettörténeti, művelődéstörténeti kérdésekre vonatkozó újabb kutatások tudományos fóruma. A lokális perspektíván túl igyekszik kitekinteni a regionális és univerzális összefüggésekre, így a tágran értelmezett Erdély területére nézve is közöl kiemelkedő értékkel bíró tanulmányokat. Küldetésének tekinti a hazai román és magyar tudományos műhelyekben született eredmények kölcsönös tolmácsolását. A dolgozatok nyelve főként az angol, de szakterülettől és témától függően német, román vagy magyar nyelven is közöl írásokat.