ASOCIAŢIA ARHEO VEST
TIMIŞOARA

ARHEOVEST

V_1

-IN HONOREM DOINA BENEA-

Interdisciplinaritate în Arheologie și Istorie

Timişoara, 25 noiembrie 2017

JATEPress Kiadó
Szeged
2017

Editor: Sorin FORȚIU (cu mulțumiri pentru ajutorul punctual acordat lui Andrei STAVILĂ, Cristian OPREAN, Adrian CÎNTAR și Simona REGEP)
Coordonator: Dorel MICLE
DVD-ROM: Adrian CÎNTAR
WEB: Sorin FORȚIU și Claudiu TOMA

Coperta: Alice DUMITRAȘCU
Foto copertă: Tudor VREME-MOSER, http://ideatm.ro/wordpress/

Această lucrarea a apărut sub egida:

Asociația ArheoVest Timișoara

CONSILIUL JUDEȚEAN TIMIȘ

Președinte Lorena SMADU
www.arheovest.com

ISBN 978-963-315-358-1 (Összes/General)
ISBN 978-963-315-359-8 (I. kötet/volumul)

CONTRIBUTION TO THE KNOWLEDGE OF *VIMINACIUM*'S WATER SUPPLY

*Ilija Danković**, *Ana Bogdanović***

* Institute of archaeology, Belgrade; ilija.dankovic@yahoo.de
** Belgrade; anab_88@yahoo.com

Rezumat. Săpăturile recente realizate la *Viminacium* au adus în discuţie problema aprovizionării cu apă pentru comunităţile agrare, meşteşugăreşti şi industriale ce populau arealul situat la est de castru şi oraş. Existenţa unui bazin colector al apei de ploaie a fost confirmat în unul dintre cazuri, la acesta adaugându-se şi descoperirea unui număr de 20 de fântâni. Studiul de faţă prezintă caracteristicile arheologice ale acestora printr-o analiză morfologică şi funcţională. De o atenţie specială s-a bucurat analiza microlocaţiei acestor fântâni, fiind evidenţiate trei tipuri: cele situate în interiorul necropolelor, cele din interiorul aşezărilor cu caracter economic – industrial, şi cele situate în interiorul vilelor romane. O problemă ridicată de cercetarea din domeniu se referă la cantitatea de apă extrasă din acestea şi dacă era suficientă pentru nevoile zilnice legate de activităţile domestice, agricole, creşterea animalelor şi practicarea meşteşugurilor. Analiza ceramicii şi a vaselor de bronz descoperite în interiorul acestor fântânile din interiorul vilelor romane a condus către concluzia că acestea erau folosite deopotrivă pentru a scoate şi servi apa. Cum săpăturile nu au evidenţiat prezenţa apeductelor, şi având în vedere că în decursul timpului aceste fântâni şi-au pierdut funcţionalitatea, cel puţin în sec. IV, se consideră că locuitorii de la *Viminacium* şi din zona înconjurătoare îşi satisfăceau nevoile legate de apă exploatând fântânile şi colectând apa din precipitaţii în bazine.

Cuvinte cheie: *Viminacium*, aprovizionare cu apă, fântâni.

The area located east of the *castrum* and the civil settlement of *Viminacium* has underwent extensive salvage excavations since 2003, due to the expansion of the local strip coal mine (**Fig. 1**).

During these excavations, the routes of the roads leading from the eastern gate of the *castrum* to fortlets *Pincum* (Veliko Gradište) and *Lederata* (Ram) have been determined[1]. Along these roads, the town necropolis that was in use from 2nd to 4th century CE was discovered, as well as several smaller necropoles which were probably utilized by the inhabitants of rural parts of *Viminacium's agger* and by the families of the owners of the eight roman villas discovered so far[2]. On the territory in question, a large settlement of economic-industrial character was unearthed[3].

[1] Danković, 2014, p. 557-562; Redžić *et alii*, 2014a, p. 62-65.
[2] Redžić *et alii*, 2014b, p. 66-69.
[3] Mrđić, Jovičić, 2012, p. 50-53.

Fig. 1. Map of archaeological features excavated in the eastern part of *Viminacium*'s *agger*.

During several campaigns, three separate aqueducts were located. They used to transport water to two structures interpreted as *castellum aquae* (water towers). The towers probably redistributed water to the city by pipes, which haven't been archaeologically confirmed to this date.

The excavations of the aqueducts haven't produced any evidence of branching or diversions, which raised the question of water supply of residential and other buildings discovered in this area, since the availability of clean water is essential, especially in agricultural communities. Ancient writers pointed out the importance of this resource. Varo and Columela inform us that the best land to purchase is the one that has its own spring. If this wasn't the case, the water well is the next most desirable, followed by cisterns for collecting rainwater, mountain streams, and finally the swamps[4].

Roman villas in Italy typically had cisterns as parts of a rainwater roof runoff systems[5]. This was also the case in other parts of the Mediterranean basin, while in the northern provinces water wells were more common, and it was not unusual that every household in urban environment had one[6].

The proof of rainwater collecting practice was documented only in the case of one villa near *Viminacium*. It was located in the vicinity of the aforementioned settlement. The villa consisted of a central courtyard, which was flanked by a residential building, with rooms located around a smaller inner courtyard, on one side, and by a building with three chambers on the other. A third structure was cut into the corners of these two buildings, and from it, a canal carried water out of the complex (**Fig. 2**). Without a doubt, this annex served as the collector for rainwater that washed down from the roofs of other buildings.

Fig. 2. Villa with rainwater roof runoff system (collector marked by yellow line).

[4] Bannon, 2001, p. 24.
[5] Thomas, Wilson, 1994, p. 140.
[6] Adam, 2005, p. 482.

During the campaigns from 2012 onwards, twenty water wells were discovered in the eastern part of *Viminacium's agger*. The morphological and functional characteristics of these features will be examined before analyzing their spatial distribution.

Depending on the water level, most wells can be classified as belonging to two main categories: water table wells and artesian wells. In the first group, water is levelled with a water-bearing layer (aquifer), while in the latter, the level is superimposed[7]. Unfortunately, the wells discovered in the vicinity of *Viminacium* cannot be attributed to either of these two groups since we do not have information about the water table layer in Roman times.

Another classification system differentiates complete (perfect) water wells which have been dug down to the waterproof layer, and incomplete (imperfect, hanging) wells, whose bottom is set in the water-bearing layer[8]. Seven water wells from *Viminacium* can be classified as belonging to the first group, while the other three are probably complete wells too, but it cannot be confirmed with certainty. Six belong to the category of incomplete wells, while four couldn't be excavated down to the bottom, so they cannot be classified.

The majority of the wells have almost perfect vertical shafts, with occasional narrowing towards the bottom which probably wasn't intentional. There were no indications that any of the discovered wells had a "platform", which means that a bigger shaft was dug out first, thus making a platform from which the lower shaft was dug. This type of wells is identified in modern-day Hungary[9].

Water wells discovered near *Viminacium* can be classified according to the shape of the horizontal cross section of the shaft, so they can be circular (16 examples) and square (4 examples), which corresponds to the majority of wells found on the territory of the Empire, especially if the oval and rectangular ones are to be seen as variations of these two types.

Circular water wells with a wooden barrel used as a lining have the diameter of approximately 1 m. This is also the case with the wells of the same type from Italy, while the rectangular ones in this part of the Empire have an area of around one square metre[10]. Four rectangular ones from *Viminacium* have areas ranging from 1,5 to 2 m². Two water wells discovered in London have areas of 3,6 and 2,6 m², but it is important to note that these are public wells with complicated mechanisms for drawing water[11].

In all likelihood, water wells were hand-dug, with a possibility that some sort of auger could have been utilized for digging the cylindrical ones, given their perfect circular shape and unchanging diameter. Even if the latter was true, people still needed to be able to enter the shaft in order to put the lining in place. The best indicator of such activities are the steps cut into the sides of one of the wells. Similar steps have been

[7] Trumić, 1966, p. 548-549.
[8] Trumić, 1966, p. 548-549.
[9] Vaday, 2003, p. 30-31.
[10] Thomas, Wilson, 1994, p. 145.
[11] Blair, Hall, 2003, p. 23, 31.

observed in certain water wells in Italy[12]. Well digging was a specialized profession and people skilled for this job were called *putearii* in Latin[13].

Regardless of the well shaft shape, the process of their construction is identical (**Fig. 3**). A vertical shaft is dug out through the layers of the ground until the water-bearing layer is reached, and in *Viminacium* it is comprised of fine sand. As it has already been pointed out, the waterproof layer was not reached in all cases. The next step was the placement of wooden lining, always at least 15 cm above the bottom, thus leaving the gap through which water entered the well. The space around the lining was then filled with clay which created a blockage and prevented the water from entering through the walls of the well. This step was essential in cases in which the well was not dug in stone or extremely solid types of soil, because the water would eventually wash down the walls and fill the well. Another very important role of lining and clay block is the prevention of shallow contaminated waters from entering the well and spoiling water.

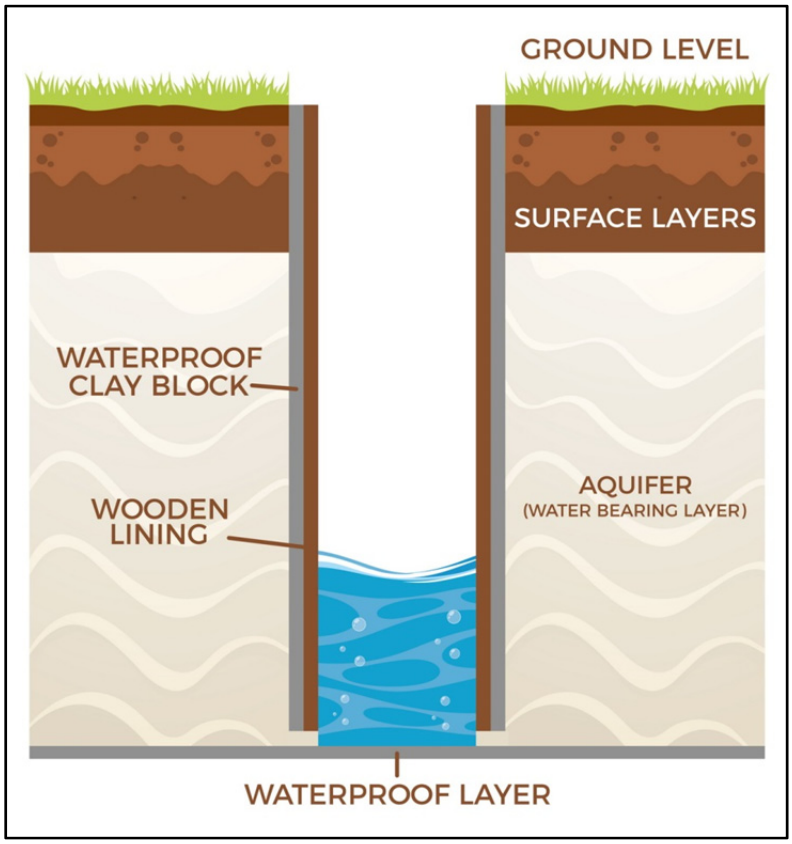

Fig. 3. Cross section of a water well.

[12] Thomas, Wilson, 1994, p. 145.
[13] Malacrino, 2010, p. 158.

The most common method of lining water wells was by using wooden barrels. First, their lids and bottoms were removed and then they were placed on top of each other until the entire well was lined (**Fig. 4**). Eleven examples from *Viminacium* had one barrel preserved, while only one had the remains of two barrels (**Fig. 5**). If the barrels originally had iron hoops, they would be removed in order to prevent water pollution by corrosion. Instead of the hoops, the barrels were fixated with withes, so they wouldn't break while being lowered into the shaft. The wells constructed in this manner are very well known across the Empire. In the neighboring provinces, 30 of them are found in *Aquincum*[14], two are from Zagreb[15], and one from *Andautonia*[16]. It can be assumed that at least one of the wells discovered in *Singidunum* (Belgrade) used to have this kind of lining, given that clay was detected along its walls. The excavation of this well was not finished due to underground waters[17]. Also, some of the archaeological features interpreted as well graves, discovered in *Viminacium* during the 20th century[18], possess some elements which could indicate that capturing water used to be their original purpose.

Fig. 4. Barrel used for the lining of the well.

Fig 5. Water well with parts of two barrels preserved.

The other method of lining the construction was with planks that formed a cross halving joint. Two water wells from *Viminacium* had this form of lining (**Fig. 6**), and it can also be assumed for two more. Cross halving joints required skilled carpenters

[14] Vaday, 2003, p. 39.
[15] Klemenc, 1935, p. 8.
[16] PGZ, 2012, p. 13.
[17] Бјелајац, Симић, 1991, p. 21.
[18] Golubović, 2008.

and also consumed more time than joining by nails and clamps made of metal[19]. The latter method was unsuitable for use in water wells because the metal parts would corrode, thus spoiling the water. Also, the former type of jointing was more durable and applied in cases when sturdiness was more important than aesthetics, which was certainly the case with water wells[20]. Examples of wells with such linings are found in England, Germany, Belgium[21] and Hungary[22].

Fig. 6. Lining with cross halving joints.

No archaeological remains that would provide the information about the above the ground parts of the water wells have been unearthed in *Viminacium*. Also, there is no evidence of any water drawing mechanisms. Most likely, the water was raised with buckets tied to ropes, which could be pulled by hand or by a simple winch. Pottery and bronze vessels discovered inside of the wells testify that smaller amounts of water for daily needs were acquired by these means (**Fig.7**).

Fig. 7. Pottery and bronze vessels on the bottom of one of the wells.

[19] Ulrich, 2007, p. 59.
[20] Ulrich, 2007, p. 68.
[21] Adam, 2005, p. 482.
[22] Vaday, 2003, p. 33-38.

The greatest portion of the material found in the wells belongs to pottery vessels. In most of the researched wells, the ceramic material is present in fragmented condition, especially in the upper levels, representing the layers of backfill. Apart from the fragmented ones, whole pottery vessels were also discovered, most often at the bottom of the well. The forms of the vessels found in these wells are typical representatives of pottery production of *Viminacium* (**Table I**). The analysis of the discovered pottery showed standardization in forms, which means that only certain types of vessels were used for the purpose of water drawing. The selection of forms is modest and consists of amphorae, pots and jugs. The most numerous finds belong to two types of amphorae, with ovoid and/or spherical recipient[23]. Contrary to this, pots and jugs represent the shapes of table vessels that are not as frequent as the amphorae. There are also two types of pots, with cylindrical neck and spherical body[24], and a pot with a rounded body with groove ornamentation[25]. Beside these two types, one specimen which belongs to biconical jug type has been found, and it represents an unusual form among the ceramic materials from *Viminacium*. The finds of table pottery in the wells, as well as the fact that all of the wells in question have been discovered within villas, suggest that water was served in the same vessels in which it was drawn. The pottery assemblage that has been found inside of the wells, as it is said above, is produced exclusively by the local workshops dated to the period from the beginning of the 2nd to the middle of the 3rd century CE. It is important to note that the analyzed pottery confirms the period during which the well was in function.

The dimensions of water wells discussed in this paper exclude the possibility that complicated water raising mechanisms consisting of chains with wooden consoles were employed in them. Such mechanisms were run by workers or animals, and have been confirmed in London[26].

The water wells discovered in the eastern part of *Viminacium's agger* can be divided into three groups based on their context:

1. Six water wells found on the necropolises;
2. Three water wells in the settlement of economic-industrial character;
3. Eleven wells found inside or in the vicinity of *villae rusticae*.

One of the water wells belonging to the first group was discovered near the graves in which, in all likelihood, the inhabitants of the nearby villa were buried. The period of its usage can be assumed based on the find of a pottery jug, dated to the period from the middle of the 2nd to the middle of the 3rd century. There are no indications that this could be one of the so-called well graves. Various activities on the necropolis required access to water, including its use in putting out the funeral pyre, washing of cremated bones and different purification rituals.

The possibility that this particular well was used for the needs of the nearby villa, i.e. for agriculture and livestock breeding, should not be ruled out. This presump-

[23] Bjelajac, 1990, p. 99-100, type XXXI.
[24] Raičković, 2007, p. 29, II/48.
[25] Nikolić-Đorđević, 2000, p. 88, TIP II/56.
[26] Blair, Hall, 2003, p. 19-21.

tion raises the question of the purity of water from the well dug out in the vicinity of the graves. There are cases in which water wells were placed near or even dug out through the layers of landfills[27]. This is not a sign of Roman negligence when the choice of the location of the wells is in question, because, as it was already mentioned, an effort was made to construct a waterproof filling in order to prevent water pollution.

The settlement of economic-industrial character was discovered about 2,4 km east of the *Viminacium* legionary camp. Within its boundaries, three water wells, which comprise the second group, were found. It is self-evident that the facilities in this settlement needed technical water. The huge effort invested in well digging shows just how important access to water was in this case. Namely, one of these wells was investigated to the depth of 21,20 m when the excavations had to be stopped because of the lack of time and workers' safety. This well had to be at least 13.25 m deeper, judging by the absolute heights of the bottoms of the completely excavated wells, from which the information about the depth of water bearing layer could be assessed. Digging a 34.5 m deep well truly is an admirable act, especially bearing in mind that the majority of wells in Roman times did not exceed the depth of 10 m, with some exceptions such as in Lahnish in Palestine - 76 m, and Haermopolis in Egypt - 35 m[28].

The effort and huge expenses of the construction of such a well have probably been the reasons for the installation of rainwater roof runoff system as a part of the aforementioned villa, which was in use in this same area before the settlement was founded.

The six water wells which belong to the third group were discovered within villas, in their courtyards, and two of them were located in the immediate vicinity of the buildings. It was possible to date majority of them to the same period in which the villas were used, according to the finds of coins and pottery vessels, while the rest of them unfortunately didn't yield any chronological material. The remaining three wells were grouped ca. 200 m from one of the villas and could have served the purpose of providing water for cattle grazing on pastures or for watering vegetable gardens.

The important question that needs to be addressed is whether the well water was sufficient to satisfy the needs of the household and the accompanying agricultural and herding activities. This was the subject of the study conducted by Robert THOMAS and Andrew WILSON (1994), which used CROPWAT (computer program developed by the United Nations) in order to calculate the amount of water needed by one roman villa. Their conclusion was that water wells were sufficient for watering the vegetable gardens and for the animals living inside of the villa. The cattle herded on pastures could drink water from the nearby rivers or streams, but it is known that water wells were dug out to fulfill this purpose[29]. Like nowadays, fields used for farming of crops were successfully watered by rainwater. As for the homestead, water wells provided enough water for personal hygiene, drinking, cooking, as well as for washing dishes and clothes. Of course, it is highly likely that the villas also had cisterns for collecting

[27] Addyman, 1989, p. 257.
[28] White, 1984, p. 157.
[29] Vaday, 2003, p. 26.

rainwater as was the case with the aforementioned building.

Concluding remarks

Based on the currently available evidence, it can be presumed that the inhabitants of the agricultural households and the settlement of economic-industrial character managed to successfully satisfy their needs for water by means of water wells, with the possible addition of rainwater collection systems. This made water from aqueducts obsolete in this part of *Viminacium's agger*.

When it comes to aqueducts, it is certain that they ceased to be functional at least in the 4th century, raising the question of water supply of the inhabitants of the city and the military camp during this period. The answer could be the same as for the features discussed in this paper. It is very likely that rainwater roof runoff systems existed, but the greatest part of the demand could be satisfied by water wells.

Perhaps the best example of a Roman city which functioned without aqueducts is *Londinium*. The needs of the citizens were satisfied by water from streams and water wells. The wells that were utilized for the demands of big spenders, city baths, for example, as well as a large number of smaller ones, used by one or more households, were discovered. The interesting fact is that *Londinium* and *Viminacium* are lying above similar geological layers. Beneath the surface layer there is a water bearing layer of sand, above the layer of waterproof clay[30]. It is possible that in the period before the 4th century *Viminacium* followed the model of *Eboracum* (York) which acquired water by means of aqueducts and numerous water wells[31].

[30] Blair *et alii*, 2006, p. 2.
[31] Addyman, 1989, p. 246.

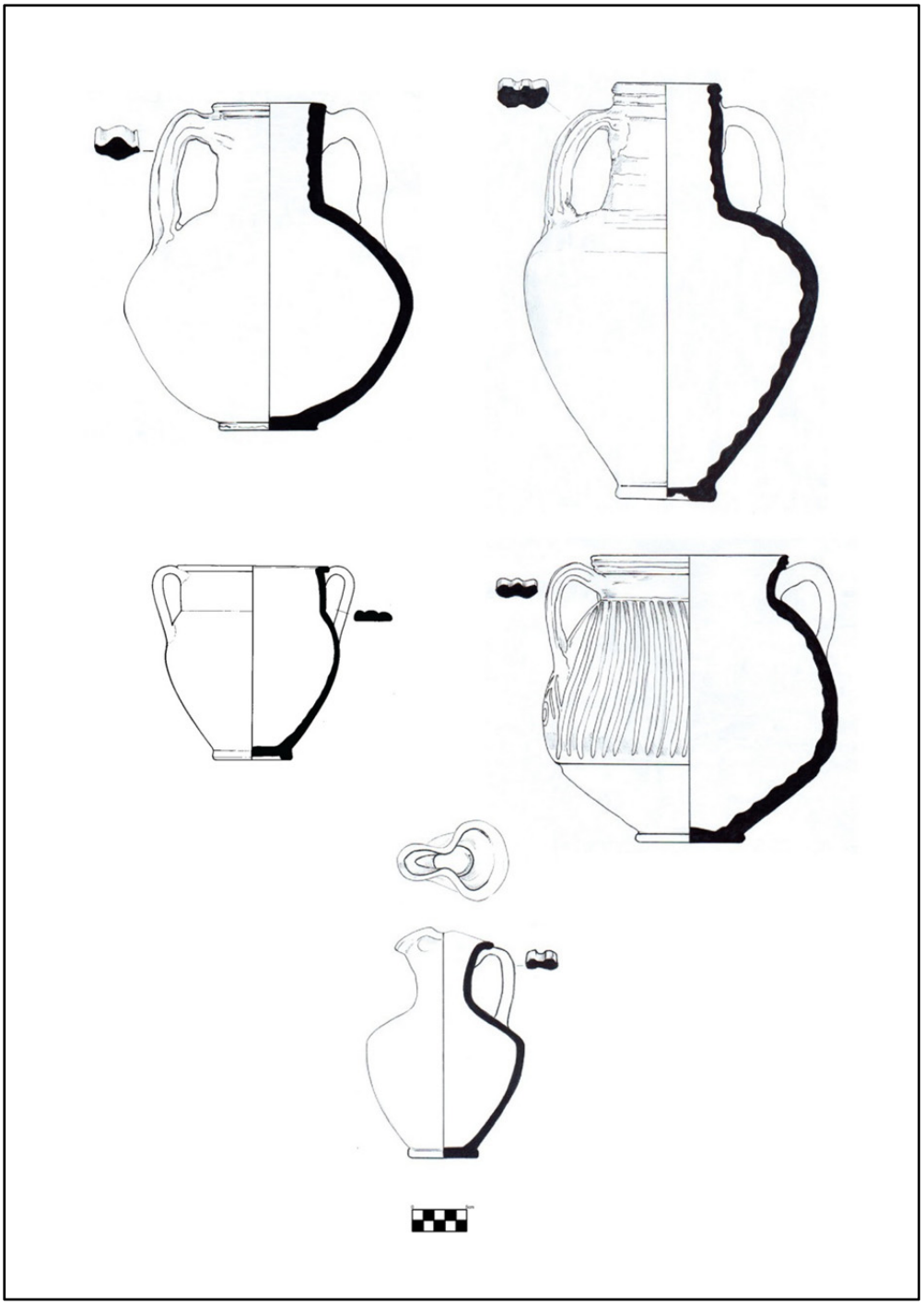

Table 1. Forms of pottery vessels discovered inside of the wells.

BIBLIOGRAPHY

Adam, 2005 — Jean-Pierre ADAM, ***Roman Building. Materials and Techniques***, Routledge, London and New York, 2005, 368 pg., ISBN 0415208661, 978-0415208666.

Addyman, 1989 — Peter Vincent ADDYMAN, *The Archaeology of Public Health at York, England*, In: *World Archaeology*, Vol. 21, No. 2, The Archeology of Public Health (Oct., 1989), pp. 244-264.

Bannon, 2001 — Cynthia J. BANNON, *Servitudes Use in the Roman "Suburbium"*, In: *Historia: Zeitschrift für Alte Geschichte*, Bd. 50, H. 1 (1st Qtr., 2001), pp. 34-52.

Bjelajac, 1996 — Ljiljana BJELAJAC, ***Amfore gornjomezijskog Podunavlja***, Arheološki institut, Beograd, 1996, 152 pg., ISBN 86-80093-09-2.

Бјелајац, Симић, 1991 — Љиљана БЈЕЛАЈАЦ, Зоран СИМИЋ, *Резултати заштитних археолошких ископавања на простору улице Кнеза Михаила*, In: *Годишњак града Београда*, XXXVIII, 1991, pp. 17-34.

Blair *et alii*, 2006 — Ian BLAIR, Robert SPAIN, Dan SWIFT, Tony TAYLOR, Damian GOODBURN, *Wells and Bucket-chains: Unforseen Elements of Water Supply in Early Roman London*, In: *Britannia*, Vol. 37, 2006, pp. 1-52.

Blair, Hall, 2003 — Ian BLAIR, Jenny HALL, ***Working Water. Roman Technology in Action***, Museum of London, 2003, 64 pg., ISBN 978-1904818496.

Danković, Petaković, 2014 — Ilija DANKOVIĆ, Svetlana PETAKOVIĆ, *Istraživanja na lokalitetu Rit (Viminacijum)*, In: *Arheologija u Srbiji: projekti Arheološkog instituta u 2013. godini*, Dragana ANTONOVIĆ (ed), 2014, ISBN 978-86-8009 3-93-2; pp. 60-63.

Golubović, 2008 — Snežana GOLUBOVIĆ, ***Grobovi u obliku bunara sa nekropola Viminacijuma***, Arheološki institut, Belgrade, 2008, 256 pg., ISBN 978-86-80093-66-6.

Klemenc, 1935 — Josip KLEMENC, *Predhistorijski i ranohistorijski spomenici na području grada Zagreba*, In: *Narodna starina*, Vol. 14, No. 35, 1935, pp. 1-14.

Malacrino, 2010 — Carmelo G. MALACRINO, ***Constructing the Ancient World. Architectural Techniques of the Greeks and Romans***, J. Paul Getty Museum, 2010, 216 pg., ISBN 1606060163, 978-1606060162.

Mrđić, Jovičić, 2012 — Nemanja MRĐIĆ, Mladen JOVIČIĆ, *Istraživanje antičkog naselja na lokalitetu Nad Klepečkom u 2011. godini*, In: *Arheologija u Srbiji: projekti Arheološkog instituta u 2011. godini*, Vesna BIKIĆ, Snežana GOLUBOVIĆ, Dragana ANTONOVIĆ (eds), 2012, ISBN 978-86-800 93-83-3; pp. 50-53.

Nikolić-Đorđević, 2000 — Snežana NIKOLIĆ-ĐORĐEVIĆ, *Antička keramika Singidunuma – oblici posuda*, *Singidvnvm 2*, Arheološki institut, Beograd, 2000, pp. 11-244.

PGZ, 2012 — ***Povijest grada Zagreba***, Knjiga 1: ***Od prethistorije do 1918***, Novi Liber, Zagreb, 2012, 450 pg., ISBN 978-953-325-020-5.

Raičković, 2007 — Angelina RAIČKOVIĆ, ***Keramičke posude zanatskog centra iz Viminacijuma***, Arheologija i prirodne nauke, Posebna izdanja 2, Centar za nove tehnologije, Arheološki institut, Beograd, 2007, 74 pg., ISBN 978-8 6-87271-00-5.

Redžić *et alii*, 2014a — Saša REDŽIĆ, Mladen JOVIČIĆ, Ilija DANKOVIĆ, *Iskopavanja na lokalitetu Nad Klepečkom (Viminacijum)*, In: *Arheologija u Srbiji: projekti Arheološkog instituta u 2012. godini*, Vesna BIKIĆ, Snežana GOLUBOVIĆ, Dragana ANTONOVIĆ (eds), 2014, ISBN 978-86-800 93-86-4; pp. 62-65.

Redžić *et alii*, 2014b — Saša REDŽIĆ, Mladen JOVIČIĆ, Ilija DANKOVIĆ, *Dve novoistražene vile rustike sa Viminacijuma – istraživanja na lokalitetima Nad Klepečkom i Rit u toku 2011/2012. godine*, In: *Arheologija u Srbiji, projekti Arheološkog instituta u 2012. godini*, Vesna BIKIĆ, Snežana GOLUBOVIĆ, Dragana ANTONOVIĆ (eds), 2014, ISBN 978-86-80093-86-4; pp. 66-69.

Trumić, 1966 — Aleksandar TRUMIĆ, *Bunari*, In: *Tehnička enciklopedija 2*, Beto-C, Jugoslavenski leksikografski zavod, Zagreb, 1966, 675 pg.

Thomas, Wilson, 1994 — Robert THOMAS, Andrew WILSON, *Water Supply for Roman Farms in Latium and South Etruria*, In: *Papers of the British School at Rome,* Vol. 62, 1994, pp. 139-196.

Ulrich, 2007 — Roger B. ULRICH, ***Roman Woodworking***, Yale University Press, New Haven and London, 2007, 400 pg., ISBN 0300103417, 978-0300103410.

Vaday, 2003 — Andrea VADAY, *Wells Excavated in the Carpatian BasinDuring a Decade*, In: *Antaeus*, 26, 2003, pp. 25-68.

White, 1984 — K. D. WHITE, ***Greek and Roman Technology: with 177 illustrations***, Cornell University Press, Ithaca - New York, 1984, 272 pg., ISBN 080 1414393.