A C T A M V S E I A P V L E N S I S

APULUM LI
series *ARCHAEOLOGICA ET ANTHROPOLOGICA*

CARPATHIAN HEARTLANDS
Studies on the prehistory and history of Transsylvania in European contexts, dedicated to Horia Ciugudean on his 60th birthday

NUCLEUL CARPATIC
Studii privind preistoria şi istoria Transilvaniei în context european, dedicate lui Horia Ciugudean la aniversarea a 60 de ani

Edited by /
Volum îngrijit de:

Nikolaus Boroffka
Gabriel Tiberiu Rustoiu
Radu Ota

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Horia Ciugudean

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A CLOSED ASSOCIATION OF SOME TENS OF LOOM WEIGHTS FROM AIUD – EVIDENCE FOR THE PRESENCE OF THE WARP-WEIGHTED LOOM IN BRONZE AGE TRANSYLVANIA, ROMANIA[1]

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Abstract/Zusammenfassung. Vor knapp 50 Jahren kamen im Herzen Siebenbürgens etwa 25-30 Webgewichte eines geschlossenen Fundkomplexes zutage. Es handelt sich um ein eindeutiges Indiz für die Verwendung des Gewichtswebstuhles in dieser Region. Dem Fund, der in die Übergangsphase von der frühen in die mittlere Bronzezeit (um 2050 v. u. Z.) datiert wird, wiederfuhren während seiner Bergung sowie im Museumsarchiv in den Jahren danach einige ungeklärte Dezimierungen. Er wurde bereits 1978 von Horia Ciugudean – der mit dieser Festschrift gefeiert wird – in der Literatur erwähnt, dessen Potential wurde damals jedoch nicht erkannt. Da sich aus der Bronzezeit keinerlei Textilfunde erhalten haben, welche Aufschlüsse über den technologischen Stand der Textilproduktion geben könnten, wird dem Fund nun eine besondere Aufmerksamkeit zuteil. Eine neue Methode, entwickelt von dänischen Textilforschern, ermöglicht es, anhand der Analyse der funktionalen Parameter von Webgewichten, Rückschlüsse auf die Beschaffenheit der mit ihnen hergestellten Tuche zu ziehen.

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[1] The seed for this paper was planted in 2010 during my participation in the archaeological field work carried out at the Late Bronze Age fortified settlement at Teleac, Alba County *(Judeţul. Alba)*. In this regard, I would like to thank the following persons and institutions: the honouree of this *Festschrift*, Horia Ion Ciugudean, senior researcher and then head of the Department of Archaeology at the National Museum of the Union in Alba Iulia *(Muzeul Naţional al Unirii din Alba Iulia)*, especially for providing me with access to the studied material, and Nikolaus Boroffka, researcher at the Eurasia Department at the German Archaeological Institute in Berlin *(Eurasien-Abteilung des Deutsches Archäologischen Instituts)*; Paul Scrobotă, director at the Museum of History in Aiud *(Muzeul de Istorie din Aiud)*, for granting me the permission to publish the results of this investigation; as well as The Danish National Research Foundation's Centre for Textile Research in Copenhagen *(Danmarks Grundforskningsfonds Tekstilforskningscenter)* for encouraging me to devote myself to the study of textile tools, as well as for providing me with the necessary methodological background knowledge (my special thanks go to centre leader Marie-Louise B. Nosch and her colleague Eva Andersson B. Strand).
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Key words: Bronze Age, textile production, textile tools, loom weights, Transylvania.
Cuvinte cheie: Epoca bronzului, producţie textilă, unelte textile, greutăţi pentru război de ţesut, Transulvania.

Introduction: dressing the subject.

A little less than half a century ago, presumably sometime prior to the year 1970[2], a large amount of medium-sized clay loom weights, deposited in closed association, were brought to light by chance in the eastern periphery[3] of Aiud, Alba County in the heart of Transylvania, Romania (**Fig. 1**). The inexpertly recovery of the find resulted in the irretrievable destruction of an unknown amount of poorly fired loom weights, a circumstance that precludes the determination of the total number of textile tools originally deposited and thus limits the evaluation of their true quantity. In the sequel, another eight objects seem to have been lost in connection with their archiving at the local museum, but despite these decreased prospects, the preserved amount of loom weights (**Fig. 2**) still remains sufficiently large in order to be addressed as an extraordinary, clear evidence for the presence and application of the warp-weighted loom[4] and thus an advanced textile production in the Carpathian Basin during the Bronze Age (for a discussion on the chronology, see below).

Prior to the Industrial Revolution, which gave way to modern technological developments, manufacturing textiles was an immensely time-consuming process that probably consumed "far more hours of labor per year, in the temperate climates, than pottery and food production put together"[5]. In view of this expenditure of human labour, it is hardly surprising that textile production

[2] The exact date remains unclear, but according to Horia Ciugudean, who has mentioned the find briefly in an archaeological report (1978, p. 44), the year of discovery "has to be before 1970" (personal communication via e-mail, 12 March 2014).

[3] While in Ciugudean's report (1978, p. 44) the location for the exact find spot is mentioned as a property at Ion Creangă Street, no. 122 *(Strada Ion Creangă, nr. 122)*, the inventory register at the Museum of History at Aiud *(Muzeul de Istorie din Aiud)*, where the find is stored today, divergently reports that the find was discovered on *Str. I. Creangă 126*. On account of this discrepancy, pinpointing the exact find spot proves to be problematic, as it seems to vary 2-4 houses from each other – assuming that the house numbers have been allocated according to established procedures. Strangely enough, when entering the exact find coordinates (46°18'36.3"N 23°44'04.8"E) in the web mapping service by *Google Inc.*, commonly referred to as "Google Maps", the reader can convince himself (when zooming in, applying the "Street View" function) that the house numbers 122 and 126 on *Strada Ion Creangă* seem to be identical: while in "Street View" the building clearly can be recognised as number 126, it is listed as number 122 in Google's address search box.

[4] Barber 1991, p. 91-113. *Warp* is the technical term for the yarns that are fixed at the top of the loom frame and that are being held in tension by a sequence of loom weights near the ground level. The other yarn in a woven fabric – the one that continuously is being woven over and under the *warp* – is called the weft (the words *weaving* and *web* share the same etymology).

[5] Barber 1991, p. 4.

has played a preponderant role in ancient economics[6]. However, fragile organic materials hardly ever survive the ravages of time unless they have had the advantage of being embedded in an environment that prevents them from rapid decomposition[7]. Furthermore, climate conditions in Romania, much as in many other part of Europe as well, are rather unfavourable in this respect. For this reason, it is seemingly impossible to provide a clear statement regarding the fineness of prehistoric fabrics. This raises the question as to what level of skilfulness textile craftsmanship had achieved in Transylvania during the Bronze Age?

Despite the lack of textiles, which has generally become tantamount to a lack of information, there is an indirect source of evidence that can provide insight into this matter: loom weights[8]. Being "common finds in archaeological excavations in Europe and the Near East, they represent the only remains of warp-weighted looms"[9], and thus they bear witness of extensive and varied prehistoric textile technologies in the archaeological record. Analysing the functional parameters of loom weights allows an assessment of textile production, even without the presence of textiles.

Presenting the find: Its discovery and partly mysterious disappearance.

About a decade after the loom weights from Aiud had been discovered, i.e. over a third of a century ago, then 25-year-old archaeologist Horia Ion Ciugudean – the honouree of the present *Festschrift* –, was the first to address these textile tools academically. In the course of a re-survey of the find spot and the find itself, Ciugudean was told by the land owner how he had chanced upon several tens of loom weights while cultivating a vineyard. However, at that time Ciugudean was only able to recover and register 24 specimens in total. Today it is no longer ascertainable how many objects had been destroyed and thus not been recovered, but the total amount of loom weights originally deposited can be estimated to have consisted of up to 30 objects[10] – an amount that is, in fact, very common for such caches, as will be discussed below.

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[6] Breniquet, Michel 2014.

[7] Mannering *et alii* 2009, p. 261.

[8] There is another group of finds, which shall not be discussed in this context, that also provides evidence for this, namely the impressions of textiles on the bases of pottery vessels (cf. Mazăre *et alii* 2012) or other objects (e.g. in corrosion of metal artefacts).

[9] Mårtensson *et alii* 2009;The quote is taken from the summary on the first page of the article. Since the author is only in possession of a preprint version of the article, the actual page number of the publication version cannot be specified.

[10] N. Boroffka, too, takes this view. He interprets the information available (Ciugudean 1978, p. 44) as to mean that the number of 24 loom weights merely indicates the amount of specimens that could be recovered for the museum's inventory. However, the absolute number of objects

After having studied the find superficially, mainly by means of a minor data acquisition, Ciugudean briefly mentioned the find in one of his early works within the scope of an annual report on new archaeological discoveries in the territory of Alba County, published in an earlier volume of the APULUM journal[11]. For the sake of wanting to present all available aspects concerning the find and the circumstances of its recovery as comprehensive as possible, the content of the short six-line excerpt in question – which happens to constitute the first and only mention of these objects up to now – shall be cited in an English translation:

> *c) Ion Creangă Street, no. 122.*
> *In the courtyard of the property at Ion Creangă Street, no. 122, occasioned by the planting of some vines, dozens of clay loom weights have been unearthed in association with pottery. 24 loom weights in total have been recovered, most of them being of conical shape and only three of them being of pyramidal shape. Their height varies between 9 and 14cm and the base diameter varies between 7 and 9cm. The hand-made pottery is atypical / unspecific, only a few fragments of polished black surface do seemingly indicate their dating to the Late Bronze Age.*
> (translation by the author[12])

While Ciugudean, back in 1978, still assumed that the loom weights had to be dated to the Late Bronze Age, he has meanwhile distanced himself from these initial thoughts and has today come to believe that the cache of these textile tools rather must be antedated to the Early Bronze Age III, which he dates to c. 2200-1900 BCE[13].

– Excursus on the chronology and cultural aspects of the area of investigation –

According to the current state of research, a reliable absolute chronology of the Bronze Age in Romania, based on radiocarbon data, is still insufficient[14]. Instead, numerous approaches are based on various relative chronology schemes, which are linked to "'cultural aspects' in the region [that] have not generally been precisely defined" (ibid.). N. Boroffka, who is an expert in this matter, is of

originally found on site – paraphrased as *several tens* (cf. the author's translation in the text) – can be interpreted as having been higher. Personal communication via e-mail, 1 April 2014.

[11] Ciugudean 1978, p. 44.

[12] I am especially grateful to N. Boroffka who kindly crosschecked my translation, which to a greater extent was based on the online translation service provided by *Google Inc.*, commonly referred to as "Google Translate".

[13] H. Ciugudean bases the substantiation of his revision on the diagnostic pottery that had been discovered in genuine association with the loom weights. Personal communication via e-mail, 12 March 2014.

[14] Boroffka 2013, p. 880.

the opinion that at present the Bronze Age of West-Central Romania – the very region where the loom weight cache of Aiud has been found – can be divided into three subdivisions, whose chronological aspects and cultural phenomena can be outlined as follows[15]:

- Early Bronze Age (c. 3000/2500–2000/1900 BCE): beginning with the final phase of the eneolithic/chalcolithic *Coţofeni* culture, reaching its peak with the *Schneckenberg* culture (other characteristic cultural appearances: *Şoimuş*, *Roşia*, and *Livezile)*. Burial mounds arranged in small groups, mainly in mountainous terrain *(Tumulus grave group of western Transylvania)*. Minor, unfortified settlements located in the vicinity of burials as well as in the lower-lying areas and valleys, where ground-level cist graves might be expected (not yet found).

- Middle Bronze Age[16] (c. 2000/1900–1500/1400 BCE): *Wietenberg* culture, phases A (I) to D (IV) (other characteristic cultural appearances: *Vatina*, *Mureş*, *Otomani*, and *Suciu de Sus*). Numerous settlements in all altitudes and landscapes, burials identified as cremation and urn deposition.

- Late Bronze Age (c. 1500/1400–1200/1100 BCE): *Noua* culture (other characteristic cultural appearances: *Berkesz, Cruceni-Belegiş*, *Igriţa*, *Ciumeşti*, and *Lăpuş*). Settlements and burials – mainly flat grave cemeteries with body burials – located in lower altitudes and river valleys.

But to return to the current topic, the loom weights from Aiud: After its discovery, the find was incorporated into the prehistory collection at the Museum of History in Aiud *(Muzeul de Istorie din Aiud)*, responsible for preserving archaeological discoveries from the region. Here, the find is still stored today, although not on display for the public. At an unknown point in time during the last decades, probably not all too long after the handover of the find in the late 1970's, several of the 24 loom weights, which had been recovered and published by Ciugudean[17], seem to have disappeared, or in any case cannot be located at present.

[15] Boroffka 2013, p. 881-890; 2005, p. 125-127.
[16] Boroffka emphasises that "'bronze' in the strict sense of tin-copper alloys, does not actually appear before the Middle Bronze Age" and, in a slightly different wording, "that (tin) bronze becomes widely used only from the Middle Bronze Age" (both 2013, p. 880), which clarifies that the Early Bronze Age is rather to be understood as a mere Copper Age.
[17] Ciugudean 1978, p. 44, see excerpt above.

In this connection, it is important, for one thing, to mention that the handwritten inventory register of the museum only mentions the receipt of 23 loom weights,[18] which is one less than mentioned by Ciugudean. It remains uncertain whether this single loom weight has ever existed[19] and, if so, how it might have gone astray.

For another thing, regarding the amount of 23 loom weights that were officially given to the museum, it can be mentioned that in summer 2011, the author was able to locate merely 15 loom weights, which were inspected for the purpose of a documentation and a subsequent analysis, whose results are presented in this paper. The whereabouts of the remaining eight specimens likewise remains uncertain.

Taking stock: Cache of some 30 loom weights from Aiud.

The 15 remaining loom weights that were encountered for investigation on July 21 in 2011 were all stowed away in an old big baggy banana box, most of them intact and in good condition while others more or less fragmented though reconstructable to the greatest extent.

According to the inventory registry of the museum, the 20 conical shaped loom weights are listed under the inventory numbers 14.091 to 14.110, whereas the remaining 3 truncated pyramidal loom weights join in numerical order, being listed under the inventory numbers 14.111 to 14.113. However, in contradiction to this information, two of the loom weights that could be located – namely the one with the lowest inventory number (14.091), as well as the one with the highest inventory number (14.110) – are in fact both truncated pyramidal in shape (the inventory number for the third specimen remains unclear, as it apparently is missing). Accordingly, it can be concluded that the inventory registration at the Museum of History in Aiud has been carried out somewhat erroneous or at least not clearly comprehensible from today's perspective.

With regard to the discrepancies just described, it should be emphasised that the following inventory list does not reflect the content of the museum's inventory registry, but is based on the author's own actual observations of the investigated loom weights (**Fig. 2**). It should be pointed out that the unequivocal

[18] The artefacts had been acquired for the price of 3 lei for 20 conical loom weights and 2 lei for three pyramidal loom weights (lei – plural form: leu – is the nominal of the Romanian currency). A date of the purchase is not mentioned. The total purchase money of 64 lei, according to today's currency exchange rates, converts to 14.59 EUR.

[19] Very likely, this discrepancy may be attributed to a simple typing error in the 1978 publication, as it can safely be assumed that both H. Ciugudean as well as the responsible museum staff involved have the abilities of counting correctly and telling the difference between 23 and 24 – especially when it is a matter of manifesting the counted number in written form for posterity.

identification of each single object was ensured by an individual inventory number that was written on its body.

In order to ensure a realistic reconstruction of the functional parameters of the loom weights from Aiud, it is of fundamental importance to acquire and publish the measurements of the objects heaviness (weight) and thickness (max. diameter), as will be explained in more detail below[20].

Inv. no. 14.091: Medium scale truncated pyramidal loom weight. The object has a light brownish grey colour and is broken in three pieces with an axial breaking line going through the hole, probably due to the very coarse composition of clay, which contains a number of bigger pebble stone inclusions. Weight: 598.0g, fragm. (655.0g, estim.). Height: 128.8 mm, fragm. (131.0 mm, estim.). Max. diameter: 78.5 mm, compl. Min. diameter: 38.9mm, fragm. (no estimation possible). Hole diameter: 12.8 mm.

Inv. no. 14.092: Medium scale conical loom weight of a typical Balkan type. The object has a reddish brown colour. Weight: 591.0g, fragm. (610.0 g, estim.). Height: 119.8 mm, fragm. (121.0 mm, estim.). Max. diameter: 66.8 mm, compl. Min. diameter: 31.0 mm, fragm. (no estimation possible). Hole diameter: 13.8 mm.

Inv. no. 14.093: Loom weight. *No details available, as the object appears to be missing.*

Inv. no. 14.094: Medium scale conical loom weight of a typical Balkan type. The object has a reddish brown colour and features a small grove in the top (c. 12 mm lengthwise, and with a c. 7 mm cavity). Weight: 570.0 g, fragm. (585.0 g, estim.). Height: 114.3 mm, fragm. (115.5 mm, estim.). Max. diameter: 76.3 mm, compl. Min. diameter: 27.6 mm, fragm. (no estimation possible). Hole diameter: 10.7 mm.

Inv. no. 14.095: Medium scale conical loom weight of a typical Balkan type. The object has a reddish and greyish colour. Weight: 638.0 g, fragm. (680.0 g, estim.). Height: 119.9 mm, fragm. (121.5 mm, estim.). Max. diameter: 88.7 mm, compl. Min. diameter: 32.1 mm, fragm. (no estimation possible). Hole diameter: 11.4 mm.

Inv. no. 14.096: Minor large scale conical loom weight of a typical Balkan type. The object has a reddish grey colour. Weight: 846.0 g, fragm. (855.0 g, estim.). Height: 142.6 mm, fragm. (144.0 mm, estim.). Max. diameter: 90.2 mm, compl. Min. diameter: 28.3 mm, fragm. (no estimation possible). Hole diameter: 14.5 mm.

[20] As is typical for publications of this period, Ciugudean's brief presentation of these small finds from 1978 lacks mentioning any information regarding their weight, although overall base-diameter ranges are given.

Inv. no. 14.097: Medium scale conical loom weight of a typical Balkan type. The object has a reddish grey colour and is broken in two pieces with an axial breaking line going through the hole. Weight: 603.0 g, fragm. (650.0 g, estim.). Height: 121.1 mm, fragm. (123.0 mm, estim.). Max. diameter: 83.9 mm, compl. Min. diameter: 29.5 mm, fragm. (no estimation possible). Hole diameter: 10.7 mm.

Inv. no. 14.098. Medium scale conical loom weight of a typical Balkan type. The object has a pale reddish grey colour. Weight: 612.0 g, fragm. (620.0 g, estim.). Height: 118.7 mm, fragm. (119.5 mm, estim.). Max. diameter: 82.9 mm, compl. Min. diameter: 24.3 mm, fragm. (no estimation possible). Hole diameter: 12.2 mm.

Inv. no. 14.099. Medium scale conical loom weight of a typical Balkan type. The object has a reddish brown colour. Weight: 617.0 g, fragm. (660.0 g, estim.). Height: 120.6 mm, fragm. (121.5 mm, estim.). Max. diameter: 85.6 mm, compl. Min. diameter: 32.7 mm, fragm. (no estimation possible). Hole diameter: 11.0 mm.

Inv. no. 14.100. Minor large scale conical loom weight of a typical Balkan type. The object has a light reddish brown colour. Weight: 764.0 g, fragm. (790.0 g, estim.). Height: 138.8 mm, fragm. (139.5 mm, estim.). Max. diameter: 85.1 mm, compl. Min. diameter: 30.1 mm, fragm. (no estimation possible). Hole diameter: 13.7 mm.

Inv. no. 14.101. Medium scale conical loom weight of a typical Balkan type. The object has a reddish brown colour and features a small grove in the top (c. 10 mm lengthwise, and with a c. 8 mm cavity). Weight: 614.0 g, fragm. (625.0 g, estim.). Height: 124.7 mm, fragm. (126.5 mm, estim.). Max. diameter: 77. 6mm, compl. Min. diameter: 24.5 mm, fragm. (no estimation possible). Hole diameter: 10.1 mm.

Inv. no. 14.102. Minor large scale conical loom weight of a typical Balkan type. The object has a reddish brown colour, features grey scorch marks. Weight: 708.0 g, fragm. (755.0 g, estim.). Height: 116.9 mm, fragm. (119.0 mm, estim.). Max. diameter: 92.1 mm, compl. Min. diameter: 28.6 mm, fragm. (no estimation possible). Hole diameter: 10.5 mm.

Inv. no. 14.103: Loom weight. *No details available, as the object appears to be missing.*

Inv. no. 14.104. Small Medium scale conical loom weight of a typical Balkan type. The object has a greyish colour and is broken in more than three pieces with an axial breaking line 3cm beneath the hole. Weight: 410.0g, fragm. (420.0 g, estim.). Height: 100.8 mm, fragm. (102.5 mm, estim.). Max. diameter: 75.8 mm, compl. Min. diameter: 23.4 mm, fragm. (no estimation possible). Hole diameter: 13.1 mm.

Inv. no. 14.105. Medium scale conical loom weight of a typical Balkan type. The object has a reddish brown colour with a muddy patina and features a small grove in the top (c. 13 mm lengthwise, and with a c. 12 mm cavity). Weight: 504.0 g, fragm. (535.0 g, estim.). Height: 104.8 mm, fragm. (106.5 mm, estim.). Max. diameter: 70.1 mm, compl. Min. diameter: 28.2 mm, fragm. (no estimation possible). Hole diameter: 11.1 mm.

Inv. no. 14.106. Small medium scale conical loom weight of a typical Balkan type. The object has a reddish brown colour and features dark grey scorch marks as well as a small grove in the top (c. 11 mm lengthwise, and with a c. 7mm cavity). Weight: 489.0 g, fragm. (525.0 g, estim.). Height: 92.0 mm, fragm. (95.5 mm, estim.). Max. diameter: 91.1 mm, compl. Min. diameter: 30.5 mm, fragm. (no estimation possible). Hole diameter: 9.0 mm.

Inv. no. 14.107: Loom weight. *No details available, as the object appears to be missing*.

Inv. no. 14.108: Loom weight. *No details available, as the object appears to be missing.*

Inv. no. 14.109: Loom weight. *No details available, as the object appears to be missing.*

Inv. no. 14.110: Minor large scale truncated pyramidal loom weight. The object has a dark greyish colour and is broken in two pieces with an axial breaking line 3 cm beneath the hole. Weight: 480.0 g, fragm. (570.0 g, estim.). Height: 133.2 mm, fragm. (135.5 mm, estim.). Max. diameter: 72.4 mm, compl. Min. diameter: 36.1 mm, fragm. (no estimation possible). Hole diameter: 14.2 mm.

Inv. no. 14.111: Loom weight. *No details available, as the object appears to be missing.*

Inv. no. 14.112: Loom weight. *No details available, as the object appears to be missing.*

Inv. no. 14.113: Loom weight. *No details available, as the object appears to be missing.*

Method of analysis: Reconstructing fabrics based on a loom weight.

With these sparse data at hand, it is now possible to assess the functional properties of each loom weight individually as well as when being utilised jointly in a warp-weighted loom. The method has been established and propounded by *The Danish National Research Foundation's Centre for Textile Research*[21], and its developers describe it as follows:

> *"The weight and thickness of loom weights are established as the defining functional parameters for the operation of the warp-weighted loom. A series of systematic tests demonstrated that the weight of a loom*

[21] Mårtensson *et alii* 2009; Anderson *et alii* 2008; Andersson Strand, Nosch forthcoming.

> *weight defines what yarn to use and the thread density. The thickness of a loom weight, and thus the width of the row of loom weights hanging closely together, defines the width of a fabric and – together with the weight of the loom weight – the thread count and density of the fabric. This new knowledge provides the methodological framework for archaeologists to calculate textile production possibilities from any given loom weight, as long as the weight and thickness are preserved. Furthermore it allows scholars to assess textile production on sites where no textiles are preserved."*
>
> (Mårtensson *et alii* 2009)

Explaining the entire theoretical and methodological approach in detail, with its complicated technological nature and abstract mathematical calculations and equations, would go far beyond the scope of this paper. Therefore, the reader is referred to the most essential primary literature[22]. Instead, the main and most important aspects shall be summarised here briefly, demonstrated by the concrete example of the loom weights from Aiud.

One might expect that ideally the parameters of all loom weights in such a set, presumably belonging to the same loom, would be nearly identical. However, this applies only in theory, for "as soon as one begins to investigate sets of Bronze Age loom weights, one is confronted with the fact that there are significant variations of loom weights within sets. These differences encompass not only weight and thickness but also type"[23]. It is therefore not surprising that this, too, is the case with the set of loom weights from Aiud, but – as one would likewise expect – a trend can be perceived in the scatter plot diagram (**Fig. 3**), according to which it becomes clear that the lighter the loom weight, the smaller its thickness (the opposite would be highly impractical).

Firstly, determining the weight to thickness ratio of each of the preserved 15 loom weights demonstrates that they do fall within an acceptable range and thus can be assumed to belong to one single set. The lightest loom weight from Aiud is estimated to weigh 420.0 g (inv. no. 14.104), whereas the heaviest weight is estimated to weigh 855.0 g (inv. no. 14.096). The smallest maximum diameter of these textile tools is estimated to measure 66.8 mm (inv. no. 14.092), whereas the largest maximum diameter is estimated to measure 92.1 mm (inv. no. 14.102).

Secondly, from these data the average values of a 'representative weight' will be generated, equal to the average of the set, which is chosen for applying the subsequent equations. Based on the average weight and the average

[22] Mårtensson *et alii* 2009, p. 373-398; Firth 2012, p. 134-135; Anderson Strand, Nosch forthcoming.
[23] Firth 2012, p. 134-135.

maximum diameter of all 15 loom weights, the representative average is 635.7 g / 81.1 mm (ratio = 7.84).

Warp thread tension	10g warp tension	20g warp tension	30g warp tension	40g warp tension	50g warp tension
Number of warp threads/loom weight	630 / 10 = 63	630 / 20 ≈ 32	630 / 30 = 21	630 / 40 ≈ 16	630 / 50 ≈ 13
Number of warp threads x2 loom weights	63 x 2 = 126	32 x 2 = 63	21 x 2 = 42	16 x 2 ≈ 32	13 x 2 ≈ 25
Warp threads/cm	126 / 8 ≈ 16	63 / 8 ≈ 8	42 / 8 ≈ 5	32 / 8 ≈ 4	25 / 8 ≈ 3
Number of loom weights	15 x 2 = 30	15 x 2 = 30	15 x 2 = 30	15 x 2 = 30	15 x 2 = 30
Amount of warp threads (1.20 m)	1890	945	630	473	378
Amount of weft yarn (1.20 m)	1890	945	630	473	378
Thread/yarn consumption for 1.20 m^2 cloth	3780 m	1890 m	1260 m	946 m	756 m
Time consumption for spinning the yarn	c. 76-108 h	c. 38-54 h	c. 25-36 h	c. 19-27 h	c. 15-22 h
Technical evaluation of the tool's suitability	Impracticable thread count: way too many threads per loom weight	Unlikely thread count: very many threads per loom weight	Optimal thread count	Optimal thread count	Possible thread count, though very few threads per loom weight

Tab. 1. Calculation of various loom setups with a loom weight of 630 g and a thickness of 80 mm, based on the average functional parameters of a cache of 30 loom weights (estimated amount). Aiud, Romania, Early/Middle Bronze Age, c. 2000 BCE.

Thirdly and lastly, assessing a reconstruction would need an estimate of the thickness of the yarn/thread applied, but since neither textiles nor single threads have been preserved, we are left with no other choice than basing our assumptions on a number of weaving experiments[24].

[24] Andersson *et alii* 2008.

Five various loom setups, representing five different scenarios for theoretical weaving operations with five different kinds of yarn (with 10, 20, 30, 40, and 50 g tension/warp thread, respectively) will be applied. In every setup a set of 30 loom weights will be attached to a loom, hanging in two parallel rows of each 15 loom weights, comprising an overall weight of 18.9 kg for the entire suspension. The two sequences of each 15 loom weights simulate the creation of a so-called balanced 2-row *tabby*[25] fabric that features a total width of approximately (2.40/2) = 1.20m. Given that both the weft threads (those to be woven into the system) and the warp threads (those fixed and under tension) will have the same measure of length, than the result of all five fabrics will turn out to have a size of 1.20 x 1.20 m – though with striking different texture (some of them rather impractical). For reasons of simplifying the calculation, the weight and diameter values of the average loom weight will be rounded down to 630.0 g / 80.0 mm, which does not result in any significant modification.

Analogies and concluding remarks.

The table illustrates the various possibilities, challenges and impracticalities that can be derived by methodically applying the loom weights from Aiud in theoretical weaving setups. We see that woven fabrics can be open, with a few threads per cm, or packed closely together. "In general, there would not have been the same number of warp threads attached to each loom weight. It would have been part of the skill of the weaver in setting up a loom to accommodate these variations by tying varying numbers of warp threads to each loom weight whilst retaining approximately the same tension on each warp thread and approximately the same number of warp threads per cm"[26].

With regard to the context of the find, it appears evident, just to clarify this matter, that this cache find cannot be seen in connection with a burial context. The high number of specimens itself, the associated pottery as well as the lack of human skeletal remains – or for that case any parallels – exclude this hypothesis. The presumed worthlessness of the poorly fired material, too, places an interpretation as a hoard deposition way beyond debate. Thus, the only remaining possibility left is a settlement context, a theory which – despite the meagre discovery conditions – seems to be supported by the fact that so far

[25] Also called *plain weave*, *linen weave* or *taffeta weave*, the most basic and in Bronze Age Europe still most common type of textile weave, in which the warp and weft threads are aligned in the most simple way, a criss-cross pattern where each weft thread crosses the warp threads by going over one, then under the next, and so on. The term *balanced* means that the warp/weft thread ratio is 1:1.

[26] Firth 2012, p. 135.

Bronze Age loom weights from Transylvania have exclusively been found in settlement context[27].

Especially the amount of "some tens" of loom weights, in combination with the fact that they were retrieved in closed association in a settlement context, attracts the comparison with some parallels that were found outside Romania. Two Bronze Age settlements shall here serve as comparisons, which have revealed some similar caches. Two caches of loom weights have been unearthed at the Early Bronze Age settlement of Demircihöyük, Western Turkey – one consisting of 29 loom weights (room 6) and another one consisting of 33 loom weights (room 999)[28] –, while another one has come to light in a Late Bronze Age settlement layer of the Toumba of Kastanas, Northern Greece[29], consisting of some 29-31 conical loom weights (**Fig. 4**). All three parallels bear a striking resemblance to the find from Aiud: roughly the same number of loom weights (29-33), predominantly the same type (pyramidal and conical) and close similarity in the measurements (weight, height and max. diameter).

Alternatively, and due to the absence of an enlightening photo-documentation from the moment of discovery of the dozens of loom weights from Aiud, maybe this photo from Kastanas may give us a clue as to how such a cache of about 30 loom weights looks like *in situ*.

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[27] Prisecaru 2009.
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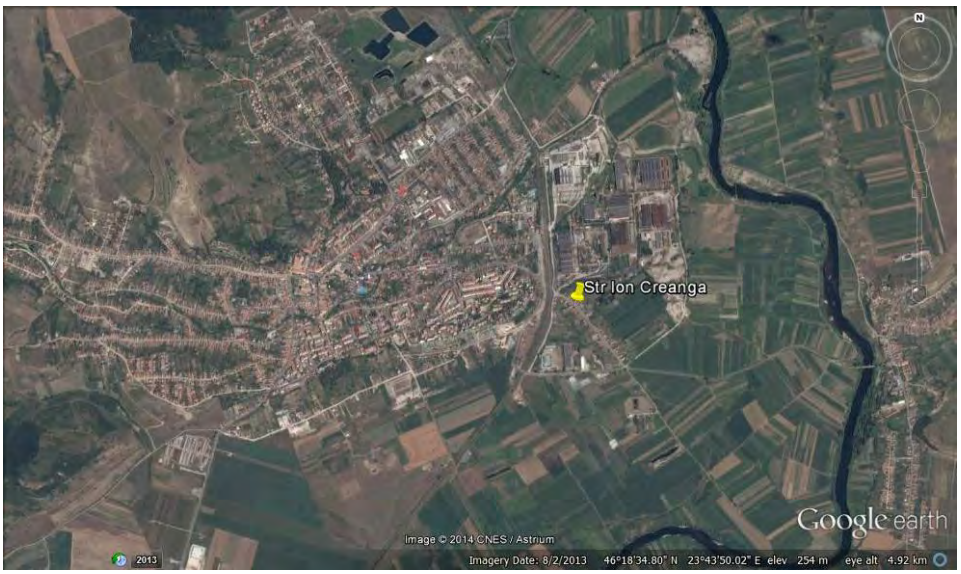

Fig. 1. Map illustrating the location of the city of Aiud where the loom weights, discussed in this paper, were discovered and where the find today is stored at the Museum for History (*Muzeul de Istorie din Aiud*). Aiud is situated at the middle course of the Mureş river, which flows through the Transylvanian Plateau, being embraced by the Western Romanian Carpathians and the Southern Carpathians.
Sources: **Map:** *Wikimedia Commons* (original file name: Romania_location_map_Topographic.png; Original creator of the map image: user Dr Brains (based on a relief computation by Hans Braxmeier, cf. http://www.maps-for-free.com), altered by Spiridon Ion Cepleanu (current file). Permission is granted to copy, distribute and/or modify this document under the terms of the *GNU Free Documentation License*.

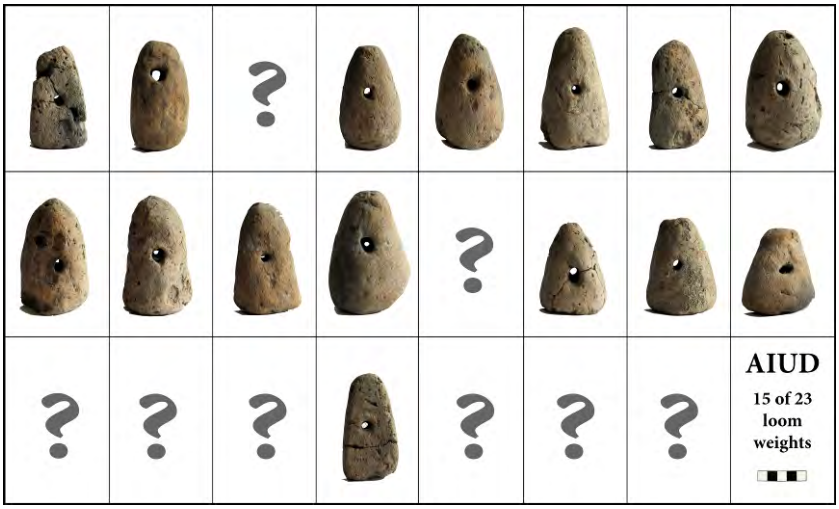

Fig. 2. The sequence of the investigated 15 loom weights from Aiud, analysed in this paper. They make up approx. half of the genuine quantity of the find (up to c. 30 specimens), of which only 24 specimens were recovered, 23 of which were listed in the museum inventory register, and of which another eight seem to have gone lost until today. The respective inventory number of each individual loom weight is given in numerical order, starting with 14.091 (top left) to 14.113 (bottom right), incl. the missing objects, which are represented by question marks.
Source: **Photos:** Sascha Mauel (by courtesy of the *Muzeul de Istorie din Aiud*). **Array:** Sascha Mauel (software applied: *Adobe Photoshop CS3*).

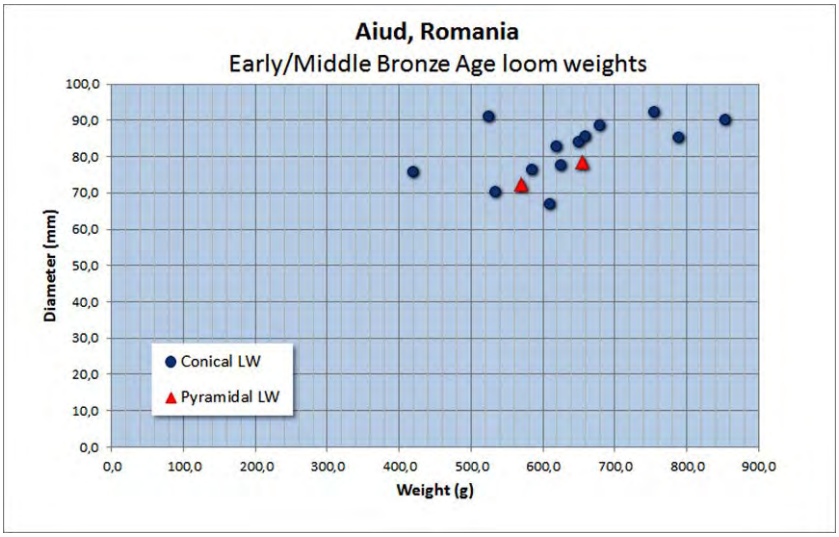

Fig. 3. Scatter plot diagram of the 15 loom weights from Aiud at the Museum of History in Aiud (*Muzeul de Istorie din Aiud*), (cf. fig. 2). Some of the specimens were slightly fragmented, thus the values of some of the plots are based on estimations. The scatter plots consist of 13 conical loom weights (blue circle) and two truncated pyramidal loom weights (red triangle). They lie on an approx. trend line, which runs diagonally from a lower left area (around 500g/70mm) to a higher right area (around 750g/90mm).
Source: **Scatter plot diagram:** Sascha Mauel (software applied: *Microsoft Office Excel 2013*).

Fig. 4. A cache of approx. 30 conical loom weights, discovered at the Toumba of Kastanas in Northern Greece. Apart from the deviating chronology (Late Bronze Age) and the fact that excavations at Kastanas were conducted systematically, the find bears a striking resemblance to the find from Aiud, discussed in this paper: approximately the same number of finds, a similar typology as well as similar measurement data. Usually, find contexts like those are interpreted as the remains of a disintegrated/decomposed (probably burned?) wooden warp-weighted loom, which had been set up with its loom weights hanging in two parallel rows.
Source: **Photo:** The *Kastanas excavation project*, 1978 (by courtesy of the excavation leader, Bernhard Hänsel, and the Athens Department of the German Archaeological Institutes *(Deutsches Archäologisches Institut, Abteilung Athen)*, where the excavation documentary is stored today).

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