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PAPERS IN THE MEMORY OF JACQUES TIXIER

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Szerkesztők • Edited by
Zsolt Mester, György Lengyel, Attila Király

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PAPERS IN THE MEMORY OF JACQUES TIXIER

Jacques Tixier, the scholar of lithic technology passed away on April 3rd, 2018. He was one of the great French archaeologists who have renewed the study of Palaeolithic sites and assemblages for reconstructing the life of past humans. He taught how lithics communicate their biography via technological stigmata and showed the importance of lithic experiments in understanding what past knappers were and were not able to do in stone tool production. Jacques' talks and demonstrations were always engaging which emerged from a lucky combination of two characters of human nature: charm and professionalism. He fundamentally affected our thinking about Prehistory, and his loss reminded us we have forgotten to thank him for all he did for us.

Shame on us for being late, we would like to express our gratitude by dedicating the volumes of 2020 to the memory of Jacques Tixier.

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STUDIES COMMEMORATING JACQUES TIXIER
A LITIKUM JOURNAL SPECIAL VOLUME

The knapped stone assemblage from Boldogkőváralja in the light of a new statistical evaluation

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Abstract

One of the most famous knapped stone assemblages, the 566 intact blades found in a large vessel at Boldogkőváralja-Tekeres-patak, dated to the Bükk culture (5200–5000 BC) has been at the forefront of the research for decades. Our intention was three-fold when we decided to reevaluate this find. First, with the publication of the conjoining workshop material, we wanted to draw more attention to the whole assemblage and not just only to the depot. Second, the deliberate selection of the artefacts found in the jar has been suggested since the 1960s, which, in our opinion, can be tested by deep statistical analysis. Third, when Vértes applied parametric and non-parametric statistical analyses on knapped stone assemblages, he ventured into a brand new branch of archaeological investigation, not just in Hungary. Unfortunately, the pioneering attempts of Vértes were not followed for many decades. Our results suggest that the intact blades of the depot differed from each other significantly by their butt preparation because the pieces with dihedral butts are significantly wider than the others. On contrary, the length and the thickness of unbroken blades are homogenous, irrespective of preparation techniques. Concerning the different butt types across the whole assemblage, blades with plain butts are the most numerous in the depot and the workshops, but other, more thorough preparation occurred at a decreased rate in the workshops. At the same time, the different preparation types are evenly distributed in the four workshops, there are no significant differences between them.

Kivonat

A boldogkőváraljai pattintott kő leletegyüttes új statisztikai értékelése

A Bükk kultúrához (i.e. 5200–5000) tartozó Boldogkőváralja-Tekeres-patak lelőhelyen talált, 566 ép kőpengét rejtő edény lerakat hazánk egyik legismertebb pattintott kő leletegyüttese, mellyel sok korábbi kutatás foglalkozott már. Újraértékelésünk első célja, hogy a depóhoz csatlakozó műhelyek leletanyagára is felhívjuk a figyelmet. Második célunk volt, hogy az edényben talált tárgyak szándékos szelekciójának elméletét statisztikai módszerekkel vizsgáljuk. Ezzel összefüggésben harmadik célunk volt, hogy a kőpengéket korában egyedülálló módon statisztikai módszerekkel vizsgáló Vértes László munkásságát folytassuk hazánkban. Eredményeink szerint a depó ép pengéi között a kétlapú talonnal rendelkezők szignifikánsan szélesebbek voltak a többinél. Ezzel ellentétben az ép darabok hosszúsága és vastagsága hasonló, függetlenül a preparációs technikáktól. A depó és a műhelyek anyagában egyaránt a sima talonú darabok a leggyakoribbak, de az alaposabb előkészítés inkább a depóba helyezett pengéken figyelhető meg. Ezen felül a különféle preparációs típusok megoszlása egyenletes a négy műhely anyagában, vagyis ezek a leletcsoportok egymásra hasonlítanak.

Keywords *Neolithic, Bükk culture, lithics, statistics, structured deposition*

Kulcsszavak *neolitikum, Bükk kultúra, pattintott kövek, statisztika, strukturált depozitum*

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1. Introduction

Considering knapped stone tools, the larger part of the Middle Neolithic (5400–5000 BC), thus the later episodes of the Alföld Linear Pottery culture are underrepresented in the literature. Moreover, the known sites and assemblages are modest, sometimes containing only a handful of pieces (Biró 1987; Biró 1998; Kaczanowska 1985). However, the relatively high ratio of obsidian (more than 50% on average) testifies the continued importance of this raw material from the former periods in the Hungarian Plain. The last decade witnessed some modest results concerning new data from new sites, such as Polgár-Ferenci-hát (Site 31) (Kaczanowska *et al.* 2016; Kaczanowska & Kozłowski 2016), Polgár-Piócási-dűlő (Nagy *et al.* 2014; Kaczanowska & Kozłowski 2016) and Tiszaug-Vasútállomás (Füzesi *et al.* 2017). At the first mentioned site, dated to the latest phase of the Alföld Linear Pottery (ALP) culture, at least two obsidian core reduction strategy was recorded, one with flat debitage surface, and one with cylindrical debitage surface. In some cases, the pressure technique was hypothesized according to the analysis of the obsidian blades. The most numerous tools are end-scrapers, laterally retouched blades, and truncations. Polgár-Piócási dűlő yielded settlement features both from the early and the latest phase of this cultural unit, with almost exclusive utilization of obsidians. One interesting difference between the two chronological horizons is the length of the blades, as the earlier specimens are larger. At Tiszaug, in the southern part of the Hungarian Plain, only a handful of stone tools were collected, but one-quarter of the pieces were made on obsidian (Füzesi *et al.* 2017). This settlement, dated to the Szakálhát culture, displays important connections with Transdanubia in the form of radiolarite artefacts, and these connections became more intensive in the Late Neolithic period.

One of the most famous assemblages, Boldogkőváralja-Tekeres-patak, which is situated in the North Hungarian Range and belongs to the Bükk culture (5200–5000 BC) has been at the forefront of the research for decades (Fig. 1) (Biró 1998; Kaczanowska 1985; Mester & Tixier 2013; Vértes 1965). However, this assemblage is peculiar in many respects. First, the abundance of obsidian raw material characteristic of contemporaneous sites is not present here at all, as this raw material counts only 3% of the whole assemblage. Second, the 566 intact blades of a local raw material (limnosilicite) (Mester & Faragó 2016) and found in a large vessel at Boldogkőváralja, are particular in themselves. This find context has been the subject of several preceding studies. Among these, Vértes' statistical study was highly uncommon in the archaeological literature before (Vértes 1965). He argued that the metrical results following normal distribution around a specific size suggest standardized manufacturing for a special purpose, thus it can be a cultural marker for a specific industry. Later, the blade depot was discussed from a technological point of view in detail, with the conclusion that the similarity of these pieces is rather the result of specialist knapping activity. (Mester & Tixier 2013). According to the latter authors, these blades have been stored in a vessel accessible to the whole community. In another article, the intertwined relationship between ritual and domestic activities was emphasized through the case study of the blade depot of

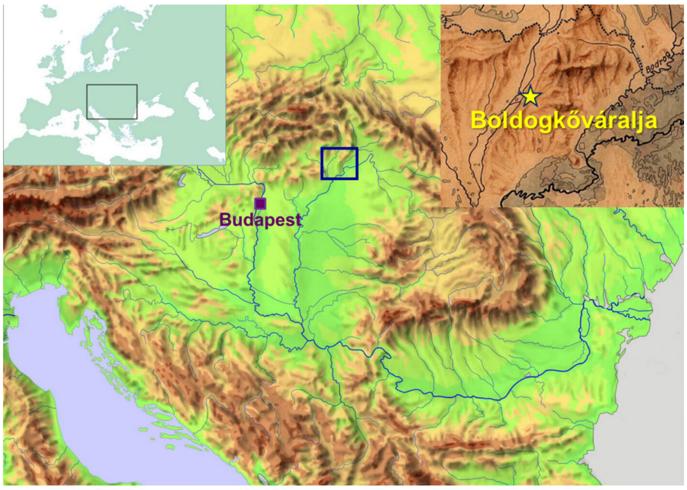


Figure 1. Location of the Boldogkőbáralja site in Hungary. Map: Zsolt Mester.

Boldogkőváralja. (Király *et al.* 2020). In this approach, the authors interpreted the knapping activity, the selection of the blades, and their deposition in the pot as possible elements of a complex ritual, which is difficult to distinguish from everyday practices. However, a detailed evaluation and publication of the lithic material from the workshops in the vicinity of the depot, never have been conducted. The only person, who investigated the material from the settlement features, only briefly mentioned the apparent metrical differences between the items from the depot and the other settlement features (Kaczanowska 1985, 52–53).

Our intention was three-fold when we decided to reconsider the analysis of the material of Boldogkőváralja-Tekeres-patak. First, with the thorough evaluation and publication of the conjoining workshop material, we wanted to draw attention to the entire assemblage from the site, not just the depot. Second, the deliberate selection of the pieces in the jar has been suggested since the 1960s (Király *et al.* 2020; Mester & Tixier 2013; Vértes 1964). At the same time, the intention of this act is obscure, and may not be ever clear, but in our opinion, it can be approached with the help of deep statistical analysis. Third, Vértes' parametric and non-parametric statistical analyses on knapped stone assemblages represent a brand new branch of archaeological investigation, not just in Hungary. At that time, natural scientific methods had just found their way into the research with the advent of new archaeology (Clarke 1968). Unfortunately, the pioneering attempts of Vértes had not been followed for many decades and statistics found their way into Hungarian Paleolithic archaeology only in the past few years (Lengyel 2018). Meanwhile, not just univariate or bivariate, but several multivariate statistical examples were introduced in the international literature already in the early years (Binford & Binford 1966; Dolukhanov *et al.* 1980; Hodson 1969). Seemingly, scholars interested in the Palaeolithic period and stone tools always have been more aware of such methods and investigations (Király 2018; Scerri *et al.* 2016).

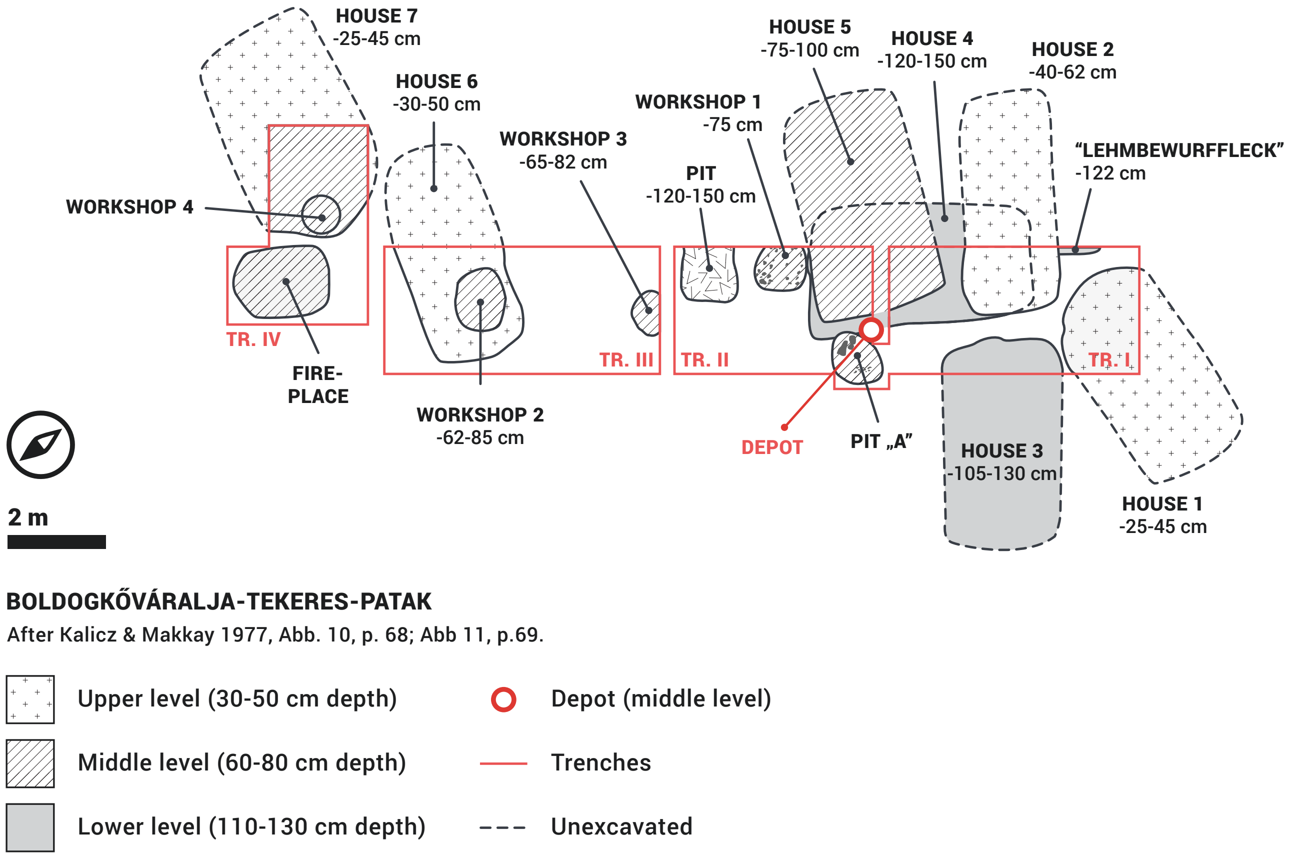


Figure 2. Excavation plan with the houses, workshops and other features belonging to the early (grey), middle (diagonal lines) and late (crosses) settlement phases, and the excavation trenches (red line). Assembled by Attila Király after Kalicz & Makkay 1977, Abb. 10 and 11.

2. Materials and methods

2.1. The archaeological site

Boldogkőváralja-Tekeres patak was discovered during road construction works by Tibor Kemenczei in 1963 (Kemenczei 1964). The site had been located near the Tekeres stream, where five trenches of 8–12.5 square meters were excavated (Fig. 2). During the excavation, 7 houses, 4 workshops, a pit, and a hearth were unearthed in four trenches. The settlement remains were dated exclusively to the Bükk culture according to the diagnostic ceramic material (Kalicz & Makkay 1977, 68–71). Based on the field observations, Kemenczei argued for two distinct settlement phases, situated between 20 and 160 cm below the topsoil. This idea was not confirmed by the ceramic analysis conducted later by Kalicz and Makkay (1977, 70), because all the sherds seemed to fit into the first phase of the Bükk culture. The famous depot in the standing vessel was found in Trench II, between House 5 and Pit 'A'.

Revising the observed depth of the different settlement features, we argue for three distinct settlement phases. The earliest part of the settlement was observed only in the southern zone in Trench I and II, represented by Houses 3 and 4 at 110–130 cm below the surface. The next level was situated in the central zone of the excavation between 60–80 cm. below the surface. Most of the activities, such as the erection of House 5, the establishment of the four workshops and Pit 'A', and the deposition of the vessel are dated to this period. Even Kemenczei associated these features with each other, representing one single settlement period. Finally, Houses 2, 6, and 7 at the level of 30–50 cm below the surface, in the distal part of the excavation area (Trench I, III, and IV) represent the last phase of occupation.

According to the examination of Piroska Csengeri, the jar containing the blades had been originally manufactured to store liquids, and after certain repairs, it ended up serving other purposes. Moreover, according to the remains cemented on the bottom and lower part of the outer wall, the lower half of the vessel was sunken into the soil while the upper half remained accessible above-ground.

2.2. Knapped stones

The excavation conducted at Boldogkőváralja yielded altogether 1083 knapped stone implements. Among them, the blade depot counted 566 pieces of intact and broken blades. Apart from that, four concentrations or workshops of knapped stones came to light with another 331 pieces of cores, flakes, and blades. 66 pieces were attributed to a feature named Pit 'A', but half of it were made of obsidian, so these pieces and further stray finds have been excluded from the present study.

Figure 3. Boldogkőváralja-Tekeres-patak, knapped stone implements and cores from Workshop 1. Photo: Norbert Faragó, courtesy of the Herman Ottó Museum in Miskolc.

Figure 4. Boldogkőváralja-Tekeres-patak, knapped stone implements and cores from Workshop 2. Photo: Norbert Faragó, courtesy of the Herman Ottó Museum in Miskolc.

Figure 5. Boldogkőváralja-Tekeres-patak, knapped stone implements and cores from Workshop 3. Photo: Norbert Faragó, courtesy of the Herman Ottó Museum in Miskolc.

The distribution of finds among the workshops is uneven; the most abundant is Workshop 2 with 111 knapped stones (Fig. 3–6). Among these, 93 pieces are blades or blade fragments, while the rest were cores, flakes, and debris. Workshops 1 and 4 contained 93 pieces each, from which 81 and 75 blades and blade fragments were chosen for the analysis respectively. Finally, Workshop 3 contained the least amount, 25 pieces suitable for study.

According to the database of Jacques Tixier and Zsolt Mester about the depot, we observed the following attributes on the pieces from the workshops: length, width, width at the mesial section, thickness, curvature, and butt type. To ensure compatibility and integrity with the depot dataset, we decided to include our measurements in the original database of the mentioned authors.

In our study, both parametric (ANOVA, Levene's, Welch) and non-parametric (Chi^2, Kruskal-Wallis, Mann-Whitney pairwise) tests were conducted with the application of the PaST 3.22 statistical software (Hammer *et al.* 2001). Every analysis was introduced by normality tests, which determined the method of comparison to follow. In the case of non-normal distribution, which was more frequent, Levene's test from median has been applied. If unequal variance occurred between the data series, the Welch test completed the evaluation. In parallel with the comparisons of the means, especially when non-normal distributions or unequal variances occurred, the medians were also compared with the help of Kruskal-Wallis and Mann-Whitney paired tests.

3. Results

3.1. Metric analysis

First, the metric attributes of the blades in the depot were investigated in more detail. The width of the intact blades was compared by the preparation technique of the blades (Fig. 7). According to the normality tests, the distribution of the butt types among blades is normal except for plain butts. In this case, the ANOVA test was run with the aid of Levene's test for homogeneity of variance from the median (p = .910). The result was a significant difference between the means of the blade widths (F[4, 392]) = 3.10; p = .016). To check the medians of the same data, the Kruskal-Wallis test was applied with similar results: they differed significantly (H = 12.51; p = .014). According to the Mann-Whitney pairwise test, the greatest distance occurred between the blades with dihedral and facetted, and dihedral and plain butts.

Blades lengths have been analysed in the same manner. First, normality tests were conducted, with similar results (Fig. 8). This time, blades with dihedral butts displayed non-normal distribution. Second, ANOVA and Levene's test have been run with the same results, both the variances (p = .805) and means were found to be the same (F[4, 392] = 1.70; p = .178). For the medians, the Kruskal-Wallis test showed strong similarity (H = 6.63; p = .157).

The analysis of blade thickness yielded similar results (Fig. 9). Except for atypical and crushed butts, all types followed

Figure 6. Boldogkőváralja-Tekeres-patak, knapped stone implements and cores from Workshop 4. Photo: Norbert Faragó, courtesy of the Herman Ottó Museum in Miskolc.

non-normal distribution. Levene's test from medians showed that the variances are the same (p = .551), so as the means (F[4, 392] = 1.80; p = .128) and the medians (H = 6.68; p = .136).

Next, the curvature of the intact blades with different butts has been compared with the same tests (Fig. 10). The normal distribution requirements of the ANOVA were strongly violated by the samples, only the blades with atypical butts followed a normal distribution. In this case, it was obvious that Levene's test from median has to be taken into consideration, which resulted in a very homogenous variance (p = .9488). Nevertheless, both means (F[4, 392] = 4.18; p = .003) and medians which were tested with the Kruskal-Wallis method (H = 16.28; p = .003) differed significantly. To identify the inherent relationships in the dataset, paired Mann-Whitney tests had been conducted again, which showed that the difference is the most significant between pieces with dihedral and facetted, and between pieces with dihedral and plain butts.

Lastly, the width of all pieces of the depot, broken or non-broken were taken into consideration (Fig. 11). According to the normality tests, the distribution of pieces with dihedral and plain butts violated the normal distribution requirements. Again, Levene's test from median was applied to inspect the homogeneity of variances, which resulted in the same variance (p = .891). The ANOVA showed that the means differ significantly (F[4, 514] = 4.22; p = .002), while the Kruskal-Wallis test verified the same for the medians (H = 16.25; p = .003). The underlying cause behind these heterogeneous distributions is the distribution of blades with dihedral butts again. According to the paired Mann-Whitney test, those blades are significantly wider than the blades having crushed, facetted, or plain butts.

The statistical evaluation of the entire assemblage was started with the investigation of blade butts (Table 1). The question arose whether the same distribution can be recorded in the depot and the workshops or not. Atypical, dihedral, crushed, facetted, and plain butts together offered an adequate sample to analyse. According to the Chi^2 test, there is a significant difference between the different assemblages concerning the distribution of butt types (X^2 = 85.50; df = 16; p < .001). Having a closer look at the distribution, only one common attribute can be noted: the most frequent butt type is plain among the whole assemblage. The facetted type is the second most abundant in the depot, while the workshops contained only a minor quantity of them. Instead, atypical butts, together with the dihedral type in equal quantities were the second most frequent groups in the workshop samples, while the depot contained only a few atypical pieces. We ran a distinct Chi^2 test only on the workshops to see the degree of the difference between them. The result was striking: there is no significant difference between the butt type distribution of the four workshops. (X^2 = 10.92; df = 12; p = .536).

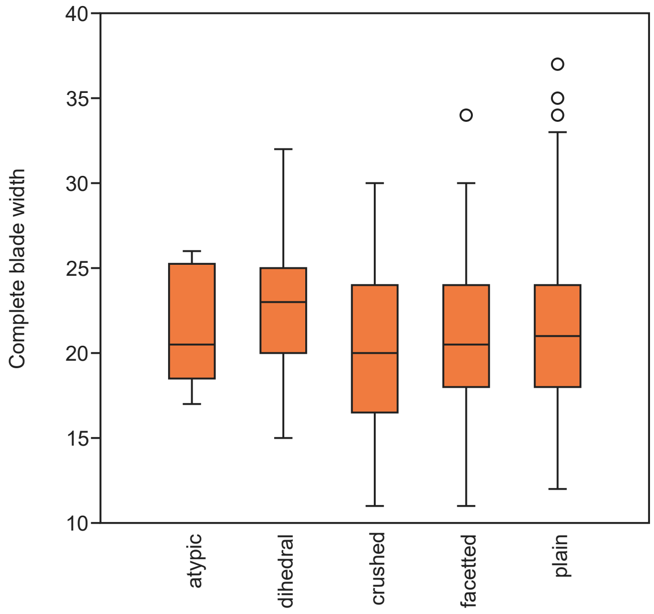
Beyond the apparent differences in the metric attributes of the blades from the depot and the workshops (Kaczanowska 1985, 52–53), we elaborated their relationship in more detail. First, the most obvious difference, the length of the whole blades were compared with each other (Fig. 12). This time, it seemed useless to run any tests, because the boxplot convincingly showed that the blades of the depot are much longer. However, we confronted the workshop assemblages with each other by ANOVA and Kruskal-Wallis tests. According to the results, the means and the medians are all the same throughout the four workshops (F[3, 53] = 0.53; p = .667; H = 2.70; p = .439), moreover, their distribution was normal.

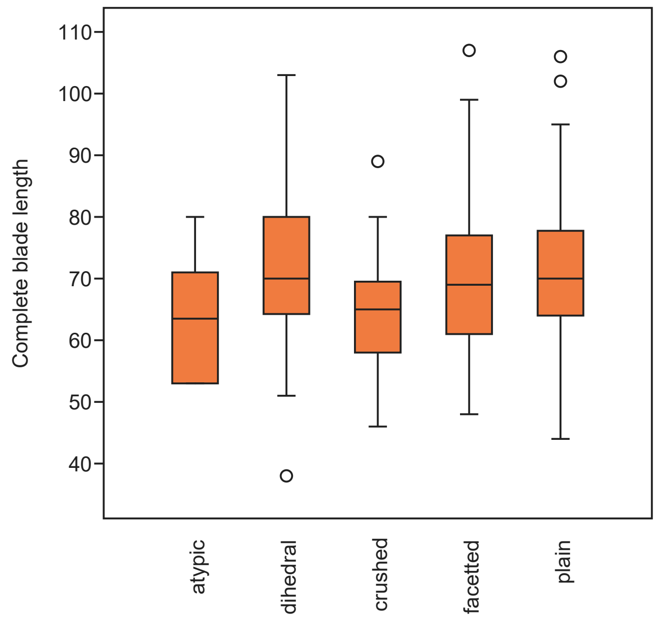
At the same time, the width data seemed less different, so it was not futile to run statistical tests on them (Fig.13). According to the normality tests, the width of the depot blades are not following normal distribution, but the blades of the workshops do. According to Levene's test from medians, the variances are not homogenous (p < .001), so the Welch F-test was applied. The result was a definitive difference between the means (F = 6.77; df = 17.96; p < .001), reinforced by the Kruskal-Wallis test for medians (H = 24.12; p < .001). Mann-Whitney pairwise tests helped to clarify the inherent relationship between the five assemblages, which reported that Workshop 1 falls close to the depot, while Workshops 2 and 3 are the most different in this sense.

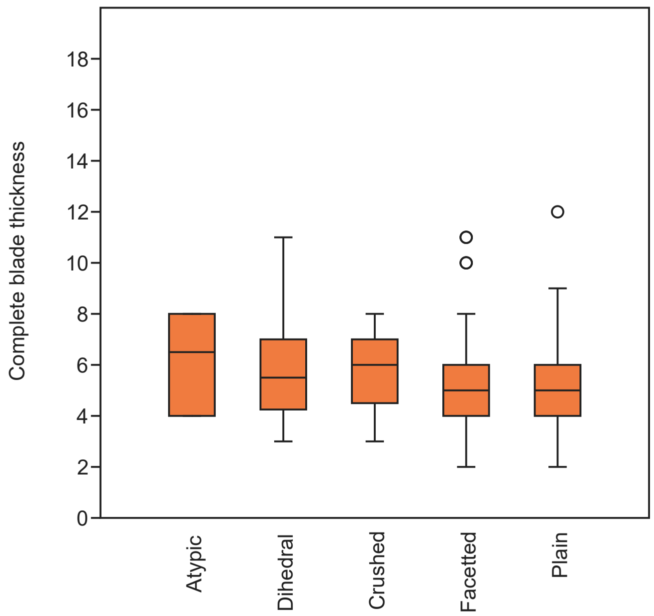
Analysing the blade thickness throughout all the assemblages, the depot seemed to be substantially different from the workshops again (Fig. 14). Blade thickness distributions are not normal, while the variances (p < .001), the means (F = 4.12; df = 17.52; p = .001), and the medians (H = 24.65; p < .001) are all heterogeneous. The Mann-Whitney pairwise test revealed that Workshop 1 stands close to the depot, while the rest of the workshops are more similar to each other again.

Theoretically, the curvature of the whole blades are closely related to the length of the blades (Fig. 15). As the blades of the depot are much larger, so one would expect more curved pieces in this assemblage as well. According to the boxplot, this claim is true, as the values of the depot are much higher than the workshops. Comparing again the four workshops with each other, non-normal distributions were experienced this time. However, Levene's test of variance from medians reinforced the homogeneity of these assemblages, and their means and medians were proved to be the same again (F[3, 53] = 0.37; p = .776; Kruskal-Wallis H = 3.35; p = .310).

The last aspect investigated is the width of all broken and unbroken blades from the depot and the workshops (Fig. 16). The normality tests resulted in a non-normal distribution in all cases, so Levene's test from medians was applied to test the variance (p < .001). The inhomogeneous variances allowed only the application of the Welch F-test, which showed that there is a significant difference between the medians of the different assemblages. (F=12.15; df[total] = 128.8; p < .001) The Kruskal-Wallis test reinforced this suggestion with the comparison of the medians (H = 65.30; p < .001), while the Mann-Whitney pairwise test shed light on the distance between the depot and the rest of the workshops.







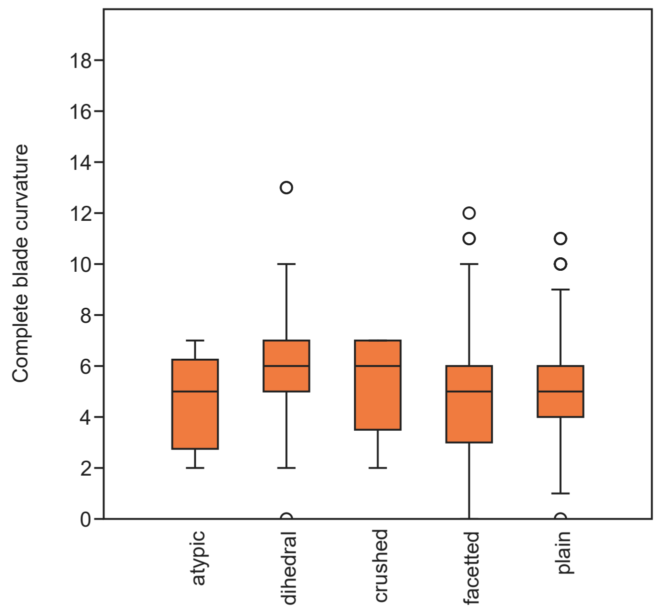


Figure 7–10. Boldogkőváralja-Tekeres-patak, metric attributes of the complete blades with different butts (atypic, dihedral, crushed, facetted, plain). Upper left (Figure 7) – width; upper right (Figure 8) – length; lower left (Figure 9) – thickness; lower right (Figure 10) – curvature. Scale is in millimeters. Assembled by Norbert Faragó.

4. Discussion

Although the Neolithic is more representative concerning the number of sites and the knapped stone tools than the Paleolithic, stone tools in obviously special deposits like the Boldogkőváralja example are very scarce in the territory of Hungary even in the former period. Apart from knapped stones deposited in graves (Faragó 2017; 2019; Siklósi 2013), our knowledge about the complex role of these artefacts in the one-time social life is extremely limited. A similar deposit from Early Neolithic times, in the context of the Körös culture, has been found at the site Endrőd 39 (Kaczanowska et al. 1981). Here, a 50 × 50 m area was excavated for about five seasons beginning in 1975, under the direction of János Makkay in connection with the fieldwork of the MRT (*Magyar Régészeti Topográfia* – Hungarian Archaeological Topography). A total of three houses and six pits were excavated, and the finds in question were recovered in the north-western half of the excavation area in 1976. To the west, near a partially excavated building, a stone hearth was found. Adjacent to the latter, an ash pit came to light, containing a rounded, cylindrical-necked jar covered with a fragment of a base, with 101 knapped artefacts inside. The stones all showed a southern origin, with raw material from the western Banat or the pre-Balkan plateau. Their technological characteristics were also fairly uniform, being exclusively flakes associated with a later stage of core reduction. The refitting analysis of a few pieces also provided an excellent sketch of the tool production process, with the authors assuming three cores.

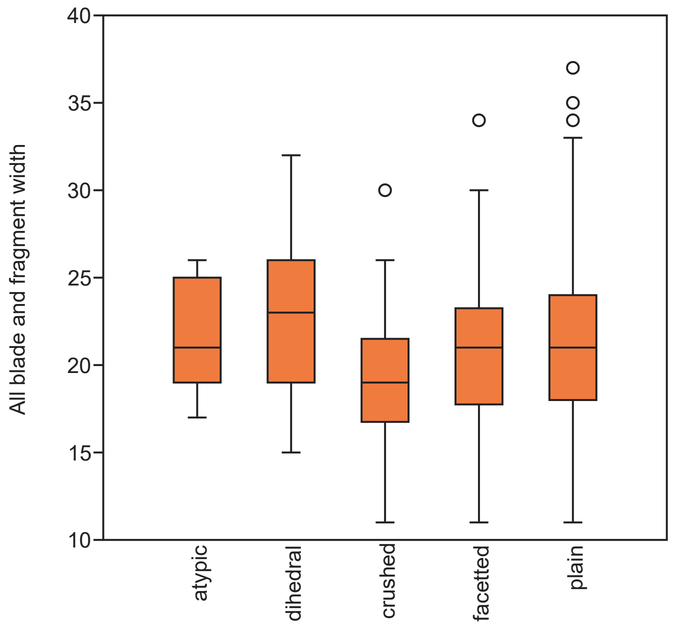


Figure 11. Boldogkőváralja-Tekeres-patak, width values of the complete and fragmentary blades with different butts (atypic, dihedral, crushed, facetted, plain). Scale is in millimeters. Assembled by Norbert Faragó.

	Atypic	Dihedral	Crushed	Facetted	Plain
Depot	6	80	13	138	160
Workshop 1	6	6	1	4	26
Workshop 2	4	7	1	4	31
Workshop 3	3	1	0	0	13
Workshop 4	2	7	4	2	31

Table 1. Boldogkőváralja-Tekeres-patak, distribution of butt types in the depot and the four workshop areas. Assembled by Norbert Faragó.

Similar depositions are also known from the Late Neolithic period, the Hungarian example mentioned here is from Szegvár-Tűzköves (Biró 2009). The site itself is a multi-layered tell settlement, typical of the Hungarian Plain region and the period, and it is well known in Hungarian and even international research (Tálas 1987). Excavations had been carried out here for several decades, but for us, it is the work conducted in 1955 that is of interest, when a small cup-shaped vessel containing 37 stone blades was found on a building's floor during the excavation led by József Csalog. Of these finds, 33 have survived until now, except one limnosilicite item, all are radiolariates of the Úrkút-Eplény and Szentgál types from the Transdanubian region. The refitting tests were successful, almost half of the finds were (14) matching pieces (Biró 2009). The remaining blades also appeared to fit in some way into the same production processes, with a total of three different starting cores assumed. Although the blades are not retouched, the analysis of their use-wear showed their utilization, and they fit well into the general picture of the material of the tell.

Even from these rare examples, it can be stated, that the guiding principles in the establishment of these contexts vary from site to site. The only fixed element connecting these cases is the presence of a vessel as a container for the selected stone tools. Other aspects driving the selection depended on the local community and its traditions, general attributes are difficult to identify. The numerous and diverse theoretical branches of archaeology have already come to the same conclusion that the exact context of a given find assemblage is as important during the interpretation as the artefacts itself (Gosden & Malafouris 2015; McNiven 2013; Hodder 1991; Renfrew & Zubrow 1994; Robb 1998,). The introduction of the neutral term "structured deposition" came in handy where any "ritual" or "symbolic" interpretation might emerge (Richards & Thomas 1984). However, the excessive use of the term for almost every archaeological feature and phenomenon could result also in a misleading interpretation (Fogelin 2007; Garrow 2012).

During their analysis, Tixier and Mester emphasized the apparent differences between Endrőd, Boldogkőváralja and Szegvár, while they set foot in a strict material and functional domain during their interpretation (Mester & Tixier 2013, 181–183). Later, the possibility of a one-time ritual practice has been formulated during the analysis of the Boldogkőváralja blade assemblage, highlighting only some selected arguments (Király *et al.* 2020).

5. Conclusion

To sum up, the intact blades of the Boldogkőváralja depot differed from each other significantly by their butt preparation, because there is a correlation between butt types and width. The pieces with dihedral butts are significantly wider than the others, especially with facetted or plain butts. On the contrary, the length and the thickness of unbroken blades are very homogenous, irrespective of their preparation techniques. However, not length but width is in concordance with the angle of inclination in this sense, as pieces with dihedral butts are more curved than the others. Again, the differences between dihedral and facetted, and dihedral and plain butts are the largest. Taking into consideration the width of all pieces in the depot (broken and unbroken) the same observation was made, as pieces with dihedral butts are significantly wider than others.

Investigating the distribution of the different butt types across the whole assemblage, it was verified again that the depot stands out compared to the four workshops. While blades with plain butt are the most numerous in the depot and the workshops also, other, more thorough preparations occurred less frequently in the workshops. It has to be stressed, that the presence of the different preparation types is evenly distributed in the four workshops, there are no significant differences between them. It is possible, that careful butt preparation was more useful to get more suitable detachments for the depot, but in an everyday context, more simple methods were preferred. On the other side, the formation of dihedral butts also would have been inappropriate, if width and angle of inclination had been as important as length. Pieces with dihedral butts are significantly wider and more curved than the others.

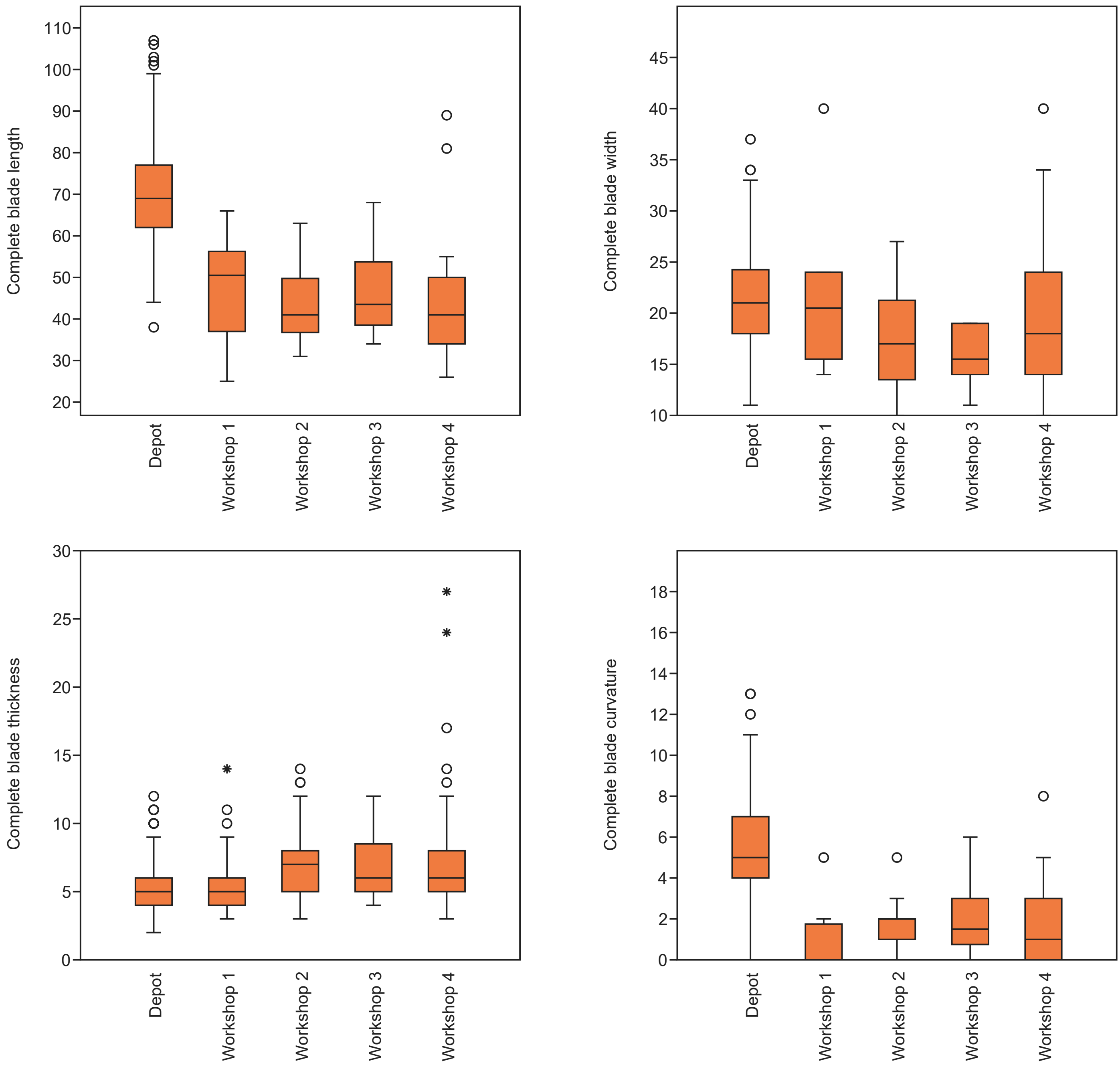


Figure 12–15. Boldogkőváralja-Tekeres-patak, metric attributes of the complete blades of the five assemblages (the depot and Workshops 1–4). Upper left (Figure 13) – width; upper right (Figure 14) – length; lower left (Figure 15) – thickness; lower right (Figure 16) – curvature. Scale is in millimeters. Assembled by Norbert Faragó.

The metric attributes of the workshops suggest the priority of the length and thickness above other measures when pieces were chosen for the depot. Whole blades left in the workshops are significantly smaller, thinner, and a bit narrower. Concerning the width of all blades and blade fragments in all assemblages from the site, this difference becomes more apparent, as the blades from the depot are much wider. The angle of inclination was in correspondence with these observations, as blades deposited in the jar are more curved than the others.

The concept of *chaîne opératoire* has been formulated in the 1960s thanks to the trailblazing work of André Lerhoi-Gourhan (Lerhoi-Gourhan 1964; 1965). Later on, several French scholars helped to transform it into a coherent theoretical framework about the complex relationship between technology and society (Pelegrin *et al.* 1988; Texier & Meignen 2012; Tixier 2012). According to this framework, the production process possesses a structure with phases and sub-phases. At certain points of this process, it is possible to deviate from a given course of events, but there are points at which it is critical to do so (Lemonnier 1989). So, tool-making itself is not only a process determined by natural laws and raw material constraints, but also has a strong human component that is culturally determined (Schlanger 1994). Moreover, the mind which encounters raw material constraints and technological possibilities is necessarily pragmatic and creative, but there is also an intellectual, theoretical aspect of thinking which views the whole process and the cultural choices it contains, from the inside out as a complex and reversible

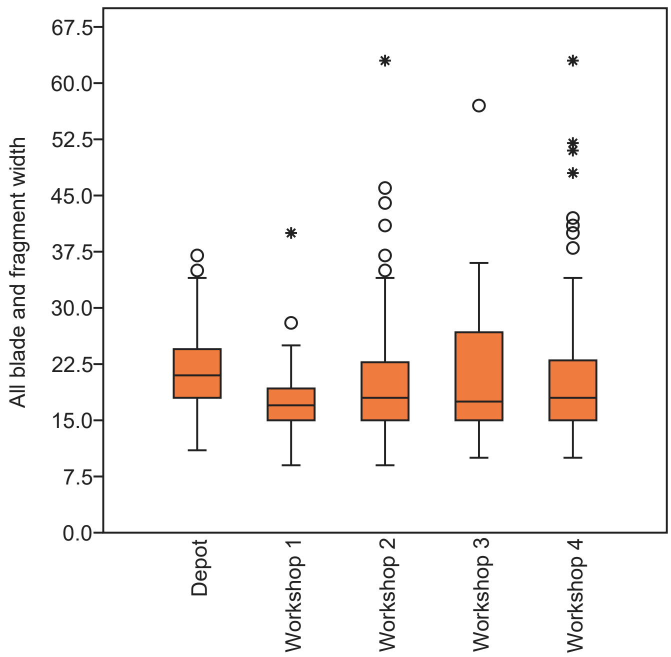


Figure 16. Boldogkőváralja-Tekeres-patak, width values of the complete and fragmentary blades of the five assemblages (the depot and Workshops 1–4).. Scale is in millimeters. Assembled by Norbert Faragó.

structure (van der Leeuw 1994). It is not surprising then when specific technological solutions are raised into a higher cognitive domain to serve as symbols. One example is the regular blade made by pressure technique, the know-how of which transferred a message during the spread of the European Neolithic into the Scandinavian region (Knuttson 2001). Another example is the manufacturing of bifacial daggers in the same region during the dawn of the Bronze Age. According to their study, the most spectacular and most skilful phases of their manufacture were not hidden at all but were performed near the places of the utilization of these tools (Apel 2008).

In conclusion, it is possible to associate all our results with the works dedicated to this blade depot. Vértes correctly emphasized the standardized nature of the metric attributes of these blades, while he mistakenly considered them as markers of a specific industry, or a cultural entity (Vértes 1965). Later, Mester and Tixier successfully argued for the technical reasons behind this standardization, advocating for technological choices over typological or metrical reasons as true cultural markers (Mester & Tixier 2013). Meanwhile, neither Vértes nor Mester and Tixier were concerned with the finds from the rest of the workshops; just Kaczanowska did (Kaczanowska 1985). However, she restricted her evaluation only to general and short statements, without a thorough evaluation and publication. Király, Faragó, and Mester later argued for the ritual aspect of assembling more than 500 very similar blades from the workshops into an accessible jar near a house, but the detailed comparison of the finds was still missing (Király *et al.* 2020). With our data and results presented here, we took one step forward to reconstruct a prehistoric act in its totality.

6. Appendices - descriptive statistics

	Depot complete blade length					Depot complete blade width				
Butt type	**atypic**	**dihedral**	**crushed**	**facetted**	**plain**	**atypic**	**dihedral**	**crushed**	**facetted**	**plain**
N	6	80	13	138	160	6	80	13	138	160
Min	53	38	46	48	44	17	15	11	11	12
Max	80	103	89	107	106	26	32	30	34	37
Sum	381	5760	846	9606	11279	128	1818	260	2854	3437
Mean	63.5	72	65.07692	69.6087	70.49375	21.33333	22.725	20	20.68116	21.48125
Std. error	4.23281	1.44235	3.07484	0.98295	0.88279	1.42984	0.45631	1.41421	0.36625	0.36103
Variance	107.50000	166.43040	122.91030	133.33480	124.69180	12.26667	16.65759	26.00000	18.51074	20.85499
Stand. dev	10.36822	12.90079	11.08649	11.54707	11.16655	3.50238	4.08137	5.09902	4.30241	4.56673
Median	63.5	70	65	69	70	20.5	23	20	20.5	21
25 prcntil	53	64.25	58	61	64	18.5	20	16.5	18	18
75 prcntil	71	80	69.5	77	77.75	25.25	25	24	24	24
Skewness	0.61045	0.38577	0.54572	0.39787	0.19619	0.38018	0.02470	0.29417	0.22973	0.61428
Kurtosis	-0.24474	0.05724	0.99597	-0.09034	0.23607	-1.40979	-0.62123	0.07203	-0.25986	0.74983
Geom. mean	62.81492	70.86329	64.22146	68.67191	69.60446	21.09733	22.35328	19.38583	20.23049	21.01127
Coeff. var	16.32791	17.91776	17.03598	16.58854	15.84048	16.41741	17.95983	25.49510	20.80353	21.25913

Appendix 1. Boldogkőváralja-Tekeres-patak. depot blade length and blade width descriptive statistics.

	Depot complete blade thickness					Depot complete blade curvature				
Butt type	**atypic**	**dihedral**	**crushed**	**facetted**	**plain**	**atypic**	**dihedral**	**crushed**	**facetted**	**plain**
N	6	80	13	138	160	6	80	13	138	160
Min	4	3	3	2	2	2	0	2	0	0
Max	8	11	8	11	12	7	13	7	12	11
Sum	37	461	75	732	851	28	485	71	688	791
Mean	6.166667	5.7625	5.769231	5.304348	5.31875	4.666667	6.0625	5.461538	4.985507	4.94375
Std. error	0.74907	0.18508	0.42598	0.13784	0.11641	0.76012	0.25492	0.51410	0.18484	0.16992
Variance	3.36667	2.74035	2.35897	2.62203	2.16820	3.46667	5.19858	3.43590	4.71512	4.61946
Stand. dev	1.83485	1.65540	1.53590	1.61927	1.47248	1.86190	2.28004	1.85362	2.17143	2.14929
Median	6.5	5.5	6	5	5	5	6	6	5	5
25 prcntil	4	4.25	4.5	4	4	2.75	5	3.5	3	4
75 prcntil	8	7	7	6	6	6.25	7	7	6	6
Skewness	-0.36154	0.90528	-0.19687	0.93875	0.94190	-0.39249	0.47973	-0.80978	0.38781	0.42785
Kurtosis	-2.10274	0.88363	-0.62615	1.69411	2.04846	-0.94305	1.23262	-0.94449	0.59394	0.40446
Geom. mean	5.91913	5.54505	5.56216	5.07041	5.12720	4.29758	0.00000	5.08627	0.00000	0.00000
Coeff. var	29.75429	28.72711	26.62219	30.52716	27.68472	39.89783	37.60888	33.93947	43.55489	43.47494

Appendix 2. Boldogkőváralja-Tekeres-patak. depot blade thickness and blade curvature descriptive statistics.

	Whole assemblage complete blade length					Whole assemblage complete blade width				
Assemblage	**Depot**	**Workshop 1**	**Workshop 2**	**Workshop 3**	**Workshop 4**	**Depot**	**Workshop 1**	**Workshop 2**	**Workshop 3**	**Workshop 4**
N	405	7	17	6	27	402	7	17	6	27
Min	38	37	31	34	26	11	14	10	11	10
Max	107	66	63	68	89	37	24	27	19	40
Sum	28407	352	741	278	1200	8604	135	287	95	538
Mean	70.14074	50.28571	43.58824	46.33333	44.44444	21.40299	19.28571	16.88235	15.83333	19.92593
Std. error	0.58025	3.99830	2.33273	4.86256	2.79159	0.21874	1.62882	1.18471	1.22248	1.38873
Variance	136.35890	111.90480	92.50735	141.86670	210.41030	19.23371	18.57143	23.86029	8.96667	52.07123
Stand. dev	11.67728	10.57850	9.61807	11.91078	14.50553	4.38563	4.30946	4.88470	2.99444	7.21604
Median	69	53	39	43.5	41	21	18	16	15.5	18
25 prcntil	62	37	36.5	38.5	34	18	15	13	14	14
75 prcntil	77	57	50.5	53.75	50	24.25	24	21	19	24
Skewness	0.35311	-0.08824	0.81670	1.38597	1.59715	0.28266	0.05926	0.31771	-0.56486	0.97823
Kurtosis	0.06704	-0.71962	-0.25837	2.33332	3.32169	0.00180	-2.25259	-0.52686	0.26078	0.95216
Geom. mean	69.17674	49.29683	42.65863	45.19256	42.53651	20.94988	18.86806	16.21022	15.57879	18.77916
Coeff. var	16.64835	21.03680	22.06576	25.70672	32.63743	20.49072	22.34534	28.93376	18.91225	36.21432

Appendix 3. Boldogkőváralja-Tekeres-patak. whole assemblage blade length and blade width descriptive statistics.

	Whole assemblage complete blade thickness					Whole assemblage complete blade curvature				
Assemblage	Depot	Workshop 1	Workshop 2	Workshop 3	Workshop 4	Depot	Workshop 1	Workshop 2	Workshop 3	Workshop 4
N	7	17	6	27	405	7	17	6	27	87
Min	4	4	5	3	0	0	0	0	0	10
Max	14	11	9	27	13	5	5	6	8	63
Sum	58	103	37	243	2109	8	32	12	45	1835
Mean	8.28571	6.05882	6.16667	9.00000	5.20741	1.14286	1.88235	2.00000	1.66667	21.09195
Std. error	1.24813	0.43276	0.65405	1.11197	0.10941	0.70470	0.26956	0.85635	0.36980	1.07692
Variance	10.90476	3.18382	2.56667	33.38462	4.84797	3.47619	1.23529	4.40000	3.69231	100.89840
Stand. dev	3.30224	1.78433	1.60208	5.77794	2.20181	1.86445	1.11144	2.09762	1.92154	10.04482
Median	8	5	5.5	7	5	0	2	1.5	1	18
25 prcntil	5	5	5	6	4	0	1.5	0.75	0	15
75 prcntil	10	7	7.5	11	7	2	2	3	3	23
Skewness	0.50383	1.39656	1.35376	1.91612	0.40169	1.87355	0.87724	1.75524	1.63931	1.97368
Kurtosis	0.60060	2.37660	1.23967	3.77949	0.59782	3.43235	3.64534	3.65703	3.27438	4.34805
Geom. mean	7.70544	5.84559	6.01266	7.72392	0.00000	0.00000	0.00000	0.00000	0.00000	19.36898
Coeff. var	39.85457	29.45006	25.97971	64.19936	42.28226	163.13980	59.04514	104.88090	115.29230	47.62395

Appendix 4. Boldogkőváralja-Tekeres-patak. whole assemblage blade thickness and blade curvature descriptive statistics.

	Depot all blade and fragment width					Whole assemblage blade and fragment width				
	atypic	dihedral	crushed	facetted	plain	Depot	Workshop 1	Workshop 2	Workshop 3	Workshop 4
N	7	103	18	178	213	564	82	108	30	87
Min	17	15	11	11	11	11	9	9	10	10
Max	26	32	30	34	37	37	40	63	57	63
Sum	151	2326	351	3663	4549	11979	1443	2129	622	1835
Mean	21.57143	22.58252	19.5	20.57865	21.35681	21.23936	17.59756	19.71296	20.73333	21.09195
Std. error	1.23167	0.42179	1.05796	0.32026	0.30797	0.18452	0.51149	0.78506	1.73995	1.07692
Variance	10.61905	18.32401	20.14706	18.25649	20.20228	19.20193	21.45333	66.56170	90.82299	100.89840
Stand. dev	3.25869	4.28066	4.48855	4.27276	4.49469	4.38200	4.63177	8.15854	9.53011	10.04482
Median	21	23	19	21	21	21	17	18	17.5	18
25 prcntil	19	19	16.75	17.75	18	18	15	15	15	15
75 prcntil	25	26	21.5	23.25	24	24	19.25	22.75	26.75	23
Skewness	0.09082	-0.00518	0.56421	0.17777	0.53205	0.28108	1.54581	2.28811	2.10980	1.97368
Kurtosis	-1.20513	-0.87198	0.78497	-0.32454	0.64478	-0.11428	5.64225	7.87460	6.19409	4.34805
Geom. mean	21.35919	22.16857	19.01785	20.12836	20.89263	20.78375	17.06288	18.46851	19.15870	19.36898
Coeff. var	15.10650	18.95561	23.01819	20.76308	21.04572	20.63151	26.32054	41.38665	45.96516	47.62395

Appendix 5. Boldogkőváralja-Tekeres-patak. descriptive statistics of complete and fragmentary blade width values in the depot and in the whole assemblage.

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Data availability statement. The authors confirm that the data supporting the findings of this study are available within the article.

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