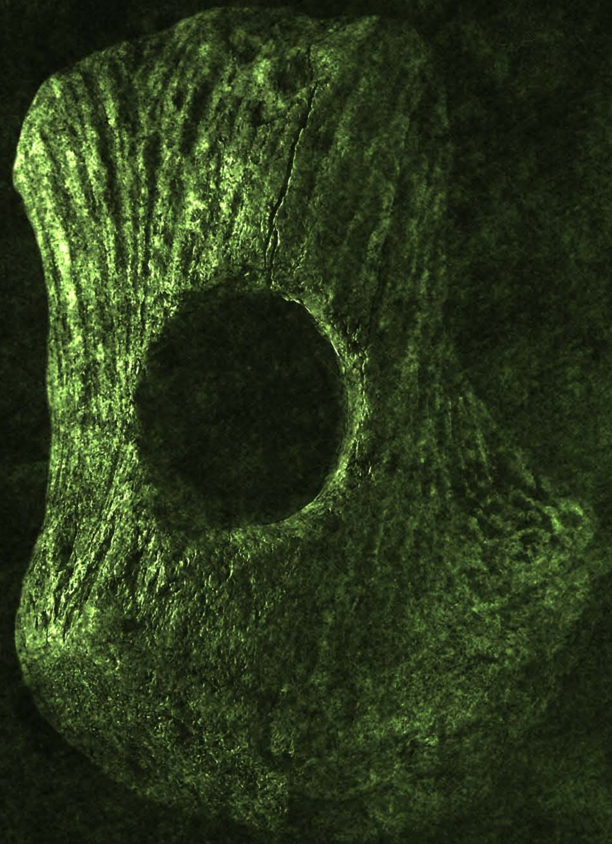
ARCHAEOTECHNOLOGY

studying technology from prehistory to the Middle Ages



Editors

Selena Vitezović

Dragana Antonović

ARHEOTEHNOLOGIJA:
proučavanje tehnologije od praistorije do srednjeg veka

Urednici:
Selena Vitezović
Dragana Antonović

Beograd, 2014

ARCHAEOTECHNOLOGY:
studying technology from prehistory to the Middle Ages

Editors:
Selena Vitezović
Dragana Antonović

Belgrade, 2014

Published by / Izdavač
Srpsko arheološko društvo
Beograd, Čika-Ljubina 18-20

For the publisher / Za izdavača
Dragana Antonović

Editors / Urednici
Selena Vitezović
Dragana Antonović

Reviewed by / Recenzenti
Markó András (Hungary), Dragana Antonović, Krum Bacvarov (Bulgaria), Jacqueline Balen (Hrvatska), Marija Buzov (Hrvatska), Heidi Luik (Estonia), Ina Miloglav (Hrvatska), Dubravka Nikolić, Ben Roberts (United Kingdom), Perica Špehar

Translation and proofreading / Prevod i lektura
Ivan Bugarski, Jelena Vitezović, Selena Vitezović and individual authors

Graphic layout / Grafička oprema
Kristijan Relić

Cover / Korica
Mihajlo Vitezović

Printed by / Štampa
DC Grafički centar
Savski nasip 7, 11070 Novi Beograd

Print run / Tiraž
100

This book is published with the financial support of the Ministry of Education, Science and Technological Development of the Republic of Serbia.

CONTENTS
SADRŽAJ

WASTED SKILL: THE CHUNK PHENOMENON

Milica Lopičić
University of Belgrade, Faculty of Philosophy –
Department of Archaeology

Abstract: *Skill is widely accepted as a factor impacting diversity among assemblages produced by knappers of different levels of expertise; however, its identification in archaeological remains is related to specific attributes and detailed analyses, usually destined to estimate abilities of pre-modern humans. This paper approaches the skill study with a broader method, cross-examining the collections to assess its suggested visibility as a formative agent. Besides skill, the raw material quality and the site function have already been acknowledged as factors influencing the lithic assemblage structure. Lack of skill, considered an uncontrolled impact on worked material, is measured by number of irregular pieces (chunks, shatter) in the assemblage. The skillful activity is thus indirectly assessed by estimating the correlation of the quantity of chunks with variables representing the site function and the quality of raw materials. This hypothesis has been tested using published data related to the general structure of lithic assemblages and associated raw materials from the Late Upper Palaeolithic and Mesolithic sites on the Balkan Peninsula, which has led to the conclusion that identifying skill from the more general information is possible, but as of yet, still not precise.*

Key words: *knapping, lithic artifacts, skill, chunk, shatter, Mesolithic, Late Upper Palaeolithic, the Balkan Peninsula.*

Apstrakt: *Razlike u stepenu veštine osoba koje okresuju kamene sirovine mogu se uočiti kao jedan od činilaca koji utiču na varijacije među tako nastalim skupovima artefakata. Ispitivanje veštine na osnovu arheoloških ostataka vezano je za pojedine atribute i detaljne analize, većinom sa namerom da se procene i uporede sposobnosti hominina. Ovaj rad opštijim pristupom ispituje uticaj veštine pri stvaranju arheoloških skupova nalaza, mereći je zastupljenošću otpadaka (nepravilnih neretuširanih proizvoda okresivanja), koji se smatraju rezultatom nekonstrolisano sprovedene sile udarca. Ranijim istraživanjima je potvrđeno da je struktura skupa kamenih artefakata u vezi sa stepenima veštine stvaralaca, kvalitetom sirovina, kao i funkcijom lokaliteta. Ta saznanja su primenjena u radu kako bi se indirektno sagledao uticaj vešte aktivnosti, na količinu otpadaka, ispitivanjem dejstva činilaca (kvaliteta sirovine i funkcije lokaliteta). Testiranje je izvršeno na objavljenim podacima o generalnim strukturama skupova nalaza i sirovinama kasnog gornjeg paleolita i mezolita sa lokaliteta na Balkanskom poluostrvu. Zaključeno je da je moguće uočiti veštinu na osnovu opštih podataka, ali se ne može interpretirati sa sigurnošću.*

Ključne reči: *okresivanje, kamene alatke, veština, otpadak, mezolit, kasni gornji paleolit, Balkansko poluostrvo.*

Introduction

Estimating skill of past people is the topic of wide interest in archaeology, involving judgment of both physical and mental abilities, giving rise to the possibility of resolving a broad series of questions. Research of skill based on the analysis of lithic artifacts is usually directed towards 1˚ assessing motor and cognitive capabilities of pre-modern humans, 2˚ isolating individuals and unique sequences of action from palimpsest of remains.

Researchers have identified and described processes and stages in acquisition of skill from the dawn of the knapping technique, which emphasized the elaborated tools and complexity of technologies of the Lower and Middle Palaeolithic, and reconstructed behavioural patterns and timing of certain evolutionary events (Delagnes, Roche 2005; Stout et al. 2009; Stout et al. 2011; Darmark 2010; Eren et al. 2011b; Geribàs et al. 2010a; Geribàs et al. 2010b; Harmand 2009; Whiten et al. 2009). Experimental studies have pointed to a number of parameters for distinguishing assemblages made by knappers of different levels of expertise (Eren et al. 2011a; Fergusson 2008; Finlay 2008; Nonaka et al. 2010; Stout 2002), and various studies have observed the significance of technologies existing in their social contexts, extending possibilities for the reconstruction of the past behaviour (Apel 2008; Högberg 2008; Högberg, Larsson 2011; Olausson 2008; Stout 2002; Stapert 2007).

Here, I examine the presence of skill as more general variable responsible for variation among archaeological collections. It has been ascertained previously that raw materials used and also site function shape techno-typological characteristics of lithic assemblage, but the question remains to what extent we can rely on those factors for explaining the assemblage structure and if skill can be accounted for as an alternative.

A View to a Skill

Skill is an individual characteristic encompassing knowledge about a task and the technical ability to fulfill that task. Knowledge provides a theoretical framework for actions to accomplish the aim, while technical know-how comes from practice and self-teaching (Apel 2008; Finlay 2008). In this research, the technical component of skill is considered, assuming that the shape of final product is predetermined in knapper’s mind, and dependent on the aim for knapping to maximize output (creating a larger tool, more practical edges, standardized tools, less waste) from processed raw material.

Studies are mostly designed to recognize and compare two (e.g. novice-expert, Geribàs et al. 2010a, and unskilled-skilled, Stout 2002) or three levels of skill (e.g. novice-apprentice-expert, Darmark 2010, and naïve-trained-expert, Stout et al. 2011), while some just recognize its state as being present-absent, or as higher-lower level of performance when comparing different technologies. Various parameters for differentiating degrees of expertise examine and quantify the knapping activity, and properties of knapped products. Knapping activity requires a complex process of preparation, such as choosing the hammer and raw material, and later behavioural sequence of individual movements and decisions, mutually dependent, and oriented towards creating the desired product. Sequence of actions ceases with the knapper's success or failure to make the desired product. Movements, gestures (manipulating the hammer and worked material, body posture, rate of knapping…) and decisions (planning the strikes, replacing hammer, abandoning worked piece) result from previous theoretical knowledge and technical dexterity and simultaneously create new knowledge and know-how. Fine changes in skill cannot be immediately assessed and realized and it usually requires years of training for one to ascend to the higher levels of expertise. Subsequent actions result in subtle improvements in skill acquisition, although not every action ends in a successful result, i.e. as a controlled impact of creating the anticipated output; however, there is an overall line of progression perceived as a mid-value of number of successes and failures during a certain period (fig. 1). This understanding of the relationship between the knapping activity, skill and the archaeological material incorporates several viewpoints (c.f. Ingold 2000; Wynn, Coolidge 2004; Roux, David 2005; Apel 2008; Tostevin 2011).

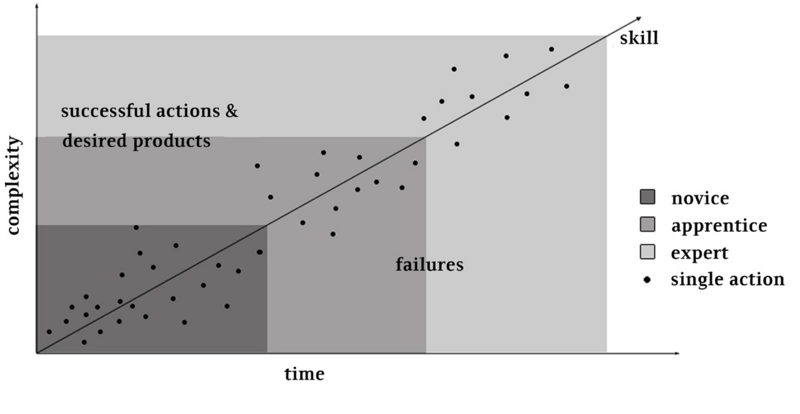


Fig. 1 Knapping skill acquisition
Sl. 1 Sticanje veštine okresivanja

Experimental studies have assessed variables and aspects of behaviour which distinguish different skill levels. An expert's movements are more even, using smaller velocities during percussion, and they have better understanding of functional parameters of knapping, such as kinetic energy, exterior angle, angle of blow and point of percussion (Bril et al. 2010; Geribàs et al. 2010a; Rein et al. 2013). Variation of parameters in artifact characteristics and assemblage as a whole also confirms the skill level of knappers, which have been ascertained by experimental studies, and tested in archaeological assemblages, like degree of symmetry of biface (Darmark 2010), successfully detaching the primary Levallois flake (Eren et al. 2011a; Lycet, Eren 2013), less chunks, less variation in artifact dimensions, making longer tools (La Torre 2004; Apel 2008; Bleed 2008). Additionally, ethnoarchaeological studies are very important for estimating and comprehending complex behavioural and decision-making patterns as well as contexts and the ways of transmitting knowledge (Roux et al. 1995; Stout 2002). In the analysis of archaeological remains, refitting is invaluable and irreplaceable at this point (until 3D artifact scanning and computer refit becomes a standard, widely used procedure) for discovering single knapping sequence enabling us to follow one's actions step by step (see Stapert 2007; Delagnes, Roche 2005; Foulds 2010).

Despite numerous studies of archaeological material and experimental knapping sequences which have been conducted, there is no agreement on a standardized set of parameters for evaluating skill level or its presence. Studies are designed to propose new methods, usually applicable to a narrow range of material, and results obtained in that way are rarely comparable to other studies' results, except in a descriptive way.

Knap-knap-knapping: on Master's Floor

The aim of this research was to try to detect the skill comparing general structures among assemblages. Chunks are the most suitable artifact category for quantifying the skillful activity. They are the unintended by-products of knapping, and as such, may be regarded as the products of uncontrolled impact, resulting from inexperienced performance of a knapper (Stout et al. 2009, 247). Additionally, previous experimental studies had asserted the connection between levels of expertise of an individual knapper and the amount of chunks produced (Finlay 2008; Stout et al. 2009).

However, lithic assemblages discovered by archaeologists are not a product of one, but palimpsest of knapping and other activities, also including non-human. The quantity of chunks during the active, living phase of the site depends not only on an individual's characteristics and behaviour during knapping sequence, but also on variety of activities which also occur at the site, and the quality of the raw material used. Statistical tests are applied to reveal those relationships; and to question the possibility of skill identification.

Chunk's not Dead

Chunk and shatter are sometimes considered and used as synonyms (Ahler et al. 2002; Stout et al. 2009), which is also true in the case of this paper. Even if definitions of those terms may differ, researchers agree that amorphous, irregular pieces are unintentional by-products of knapping. Chunk is recognized as a piece lacking platform and a ventral side (Wickham-Jones 2004, 69), or the same as a shatter piece lacking orientable fracture propagation features (Ahler 2002, C.1). Andrefsky (2005, 84) uses the term *non-flake debitage* or *angular shatter*, for all pieces lacking recognizable dorsal and ventral sides, comprising large, blocky chunks and tiny pieces of lithic material. The term flake shatter is also used, which includes all flake debitage with no recognizable striking platform (Williams, Andrefsky 2011, 867). Authors mostly report only one category for the general structure of the assemblage, without describing its exact meaning, while all fragmented pieces are sometimes considered shatter.

Previous research demonstrated that successful strike and knapping behaviour, together with morphologic, metric and stylistic artifact attributes and also assemblage structure, depended on knapping skill. Inappropriate strike leads to uncontrolled distribution of force, resulting in knapping errors, such as rough termination of flake (stepped, hinged and plunging, i.e. overshot; Andrefsky 2005, 20) and in waste, or debris (chunk, angular shatter, flake shatter)[1]. The analysis of types of distal endings and also negatives of endings on dorsal sides of flakes can also be employed for estimating the skill level, but the aim of this research is to use the general data and less detailed analysis of artifact assemblage.

It is said that chunk is a by-product and as such the result of single action and specific circumstances of particular moment, but actions also constitute some behavioural patterns. They can be approached via a broader set of data, in this case the quantity of chunks among diverse as-

[1] Not all of the chunks are waste material, some might be used, reworked, but in this paper chunk is considered as waste material. Moreover, authors use diversely terms debitage, waste, debris, sometimes as synonyms. I use debitage to refer to all detached pieces that are not transformed into tools and waste to refer to pieces lacking recognizable features.

semblages. Underlying assumptions are that experienced knappers have in mind clear form of desired product, knowledge of actions needed to make it and technical dexterity to successfully perform those actions and accomplish the desired task, and that the aim of knapping is to use raw materials to their maximum extent (i.e. minimizing the amount of waste, or making the biggest tool). Chunks in the assemblages, however, do not readily imply that this degree had not been fulfilled in the past, because other causes for chunk occurrence have not yet been investigated in more detail so far.

Shatter in Time

Archaeological assemblages do not represent past activities realistically, there are numerous cultural and natural, both formative and transformative variables, which also affect it. Lithic remains at a site depend on quality and availability of raw materials, on the activities which take place at the site, duration of settlement and frequency of visits, the structure of the residents and their personal characteristics, social relationships and cultural setting, un-intentional accidents, instantly made decisions under specific circumstances, non-human activities, natural settings and environmental conditions... Every factor is detectable in archaeological assemblage, but only if appropriate analyses are applied and while they are not all estimated here, their assessment is still required (fig. 2).

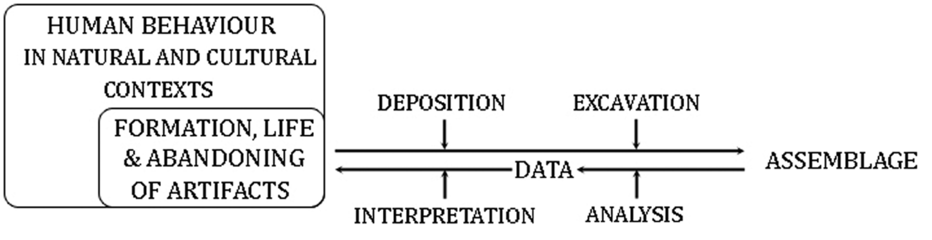


Fig. 2 Factors influencing the formation of the archaeological assemblage and later interpretation of the past
Sl. 2 Činioci koji utiču na stvaranje arheoloških zbirki nalaza i kasniju interpretaciju prošlosti

Human actors contributing directly to the quantity of chunks are knappers and their characteristics, personalities, virtues, here expressed by their levels of skill. It is believed that low-quality raw materials produce more chunks than high-quality (Kozłowski et al. 1994, 22; Adam 1997, 485).

Good quality rock combines and is both distinct as well as recognizable by attributes such as elasticity, brittlenes, hardness and homogeneity, whether or not fractures are conchoidal, and possibly controlled by a knapper applying adjusted, appropriate impact. Low quality raw materials break in unpredictable ways, usually through uncontrollable split-fractures, creating irregular pieces. It should be noted that rock used for knapping may have internal cleavage planes, flaws, fissures, vugs or other inclusions which knapper cannot predict. They inhibit the free passage of energy, thus a skillfull impact, even on high-quality rock, can produce pieces which lack common morphological features (Andrefsky 2005, 24–30; Eren et al. 2011b, 2731; Roubet 1997, 130). Activities which took place at a site are closely related to the availability of raw-materials, whether a temporary camp or more permanent form of settlement. Workshops and sites with workshop elements are usually sited near outcrops of raw-materials. It is thought that more chunks are to be present in assemblages considered workshops, displaying the evidence on knapping activity then in assemblages more closely related to daily activities and further from raw-material outcrops.

Factors which influenced the variance in quantity of chunks during the living phase at the site that were not taken into account are non-intentional human activities (such as trampling that modify lithic remains after its formation), non-human activities (animal or environmental agencies), and the duration of the occupation of a site. The diachronic approach of assessing the complex, mutual influence of various factors on their traces in archaeological material is important, but beyond the scope of this study. Some possible changes over time would result in different quantity of chunks, people may achieve higher skill levels, thus making less irregular pieces, outcrops could have even been over-exploited and exhausted, which would influence the activities, and activities can change due to other causes.

Post-depositional processes also influence the assemblage structure and they might also affect the quantity of chunks. While this is incorporated, detailed evaluation of their impact is beyond the scope of this study. Additionally, animal and human activity, natural processes, may result in the dislocation of remains or else the mixing and disturbance of archaeological layers. Archaeological research, excavations as well as later analyses, also shapes the assemblage structure. Furthermore, fieldwork variables that create the assemblage are the size of excavation surface (or volume of excavated deposits), methodology of excavations, and the experience and individual characteristics of those participating (e.g. some may not recognize chunk as knapping product and keep it as find). The very analysis of the techno-morphological structure of lithic assemblage affects data collecting and reporting, so too the definition and description of artifact groups and the classification of artifacts depend on the 'school of analysis, tradition' and the individual skill and characteristics of the lithic analyst.

To summarize, the quantity of chunks at the site during pre-depositional phase is considered to be product of 1˚ level of the skill of knappers, 2˚ use of low-quality raw materials, 3˚ activities taking place at site (fig. 3). In order to investigate the possibility of assessing the impact of the skill, statistical tests were applied to reveal the influences of the site function and quality of knapped raw materials.

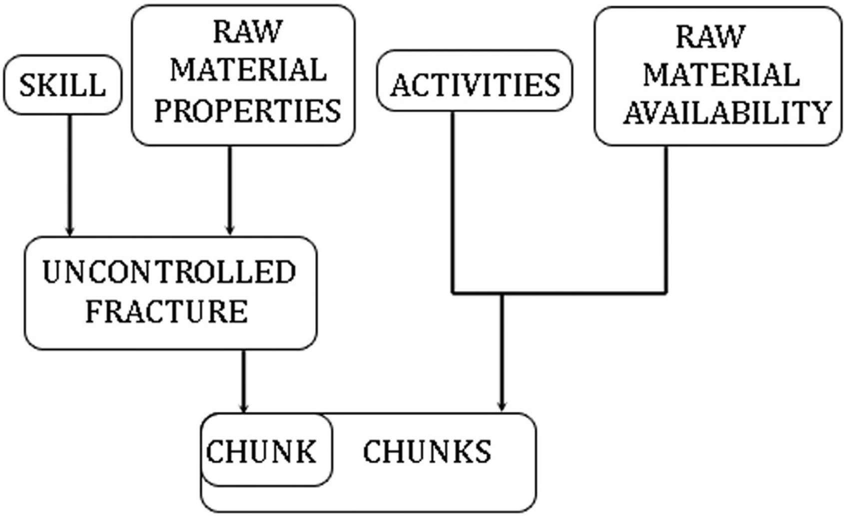


Fig. 3 Factors influencing the quantity of chunks in the assemblage
Sl. 3 Činioci koji utiču na količinu otpadaka u skupu nalaza

Materials and methods

Published data on the lithic collections originating from the Late Upper Palaeolithic and Mesolithic sites on the Balkan Peninsula was subjected to testing, dated from c. 18 000 B.C. until 7th millennium B.C. when Neolithic spread across the region. The chosen area exhibits technological and cultural uniformity during the Final Pleistocene characterized by Epigravettian. Later, during the Early Holocene, Mesolithic /Epi-Palaeolithic cultures arose in the studied territory, bearing strong Epigravettian traditions in the south and east parts of Balkan Peninsula (Kozłowski 2005).

Results of lithic analyses have been reported in diverse publications. Only assemblages larger than 100 artifacts and for which the amount of chunks is clearly stated were considered. There are 63 assemblages ascribed to Late Upper Paleolithic and Mesolithic industries originating from 19 sites having met these criteria (fig. 6).

... Every Piece You Flake.. Every Step You Make, I'll be Watching You… Quantifying Data

Quantity of chunks is expressed as proportion of the chunks in the general structure of assemblage, by counting the number of artifacts (artifacts less than 1cm in length are excepted from the analysis, and all further calculations, because it has been shown that their number depend largely on excavation technique (c.f. Bertran et al. 2012). It is also possible to express the percentage of chunk material by weight, but that is suitable for research of skill levels as better usage of raw material processed. Counting the pieces corresponds to the measurement of skill levels as number of impacts that drive force with lack of control.

Site function is assessed through technological and typological analyses of stone artifacts. Diverse activities taking places at the site are related to knapping behaviour which is determined by the availability of raw materials and procurement strategies. Initial sequences of knapping activity are closely related to extraction sites where raw material is tested and prepared as cores for later flaking. Consequently, more chunks are predicted to be at the sites closer to raw-material deposits. Data on the studied assemblages were grouped into established ordinal categories, according to proposed five functional types of the assemblages for LUP and Mesolithic periods (Kozłowski 1980). Those types involve the aspects of the past activities and the proximity of raw materials and are determined by the character of the general structure given in indices (proportions of cores, tools and debitage). Tools are poorly represented (1–4%) and debitage products strongly dominate (91–98%) at the sites qualified as workshops (types 1 and 2: workshops at extraction sites and other workshops). Higher number of tools (4–18%) and less of the debitage (78–92%) is to be found at the living sites with workshop elements or those in the areas of raw material deposits (types 3 and 4, successively). The proportion of cores remains similar for these site types (1–5% for types 1 and 2, and 1–4% for types 3 and 4). Type 5 (18–42% of tools, 1–8% of cores and 50–72% of debitage) presents the living sites outside areas containing raw material deposits. The same standards were applied to sampled assemblages.

Quality of raw materials cannot be assessed easily, due to the fact that data regarding detailed internal and knapping properties of raw materials are rarely reported, and are ambiguous sometimes. We had to rely on observation on quality of raw materials made by researchers and thus created two groups, of higher and of lower quality rocks and calculated their quantity. For the purpose of statistical testing, the index of the quality of raw material (I_{qrm}) is calculated as the ratio dividing the number of artifacts of higher-quality by the number of artifacts of lower-quality raw materials.

Tests and expectations

To investigate the relationship between site function and quantity of chunks in the assemblage, Kruskall-Wallis test was used to examine whether quantities of chunks (dependent variable) were diverse among groups (independent variable) defined as functional types of assemblages. Since groups are ordinal categories and the distance between each of them not precise, post-hoc Mann-Whitney tests were run to examine the differences in quantity of chunks between adjacent groups as well as between the most distant ones. Following criteria proposed by Kozłowski (1980) and allowing that one of artifact categories in the assemblage (cores, tools or debitage) omits the suggested ranges by up to 1%, it was possible to determine functional types for twenty eight assemblages: one collection matched type 1, two matched type 2, twelve matched type 3, eight matched type 4 and five matched type 5. However, groups 1 and 2 were omitted from further testing due to the small number of cases (fig. 4; Appendix 1).

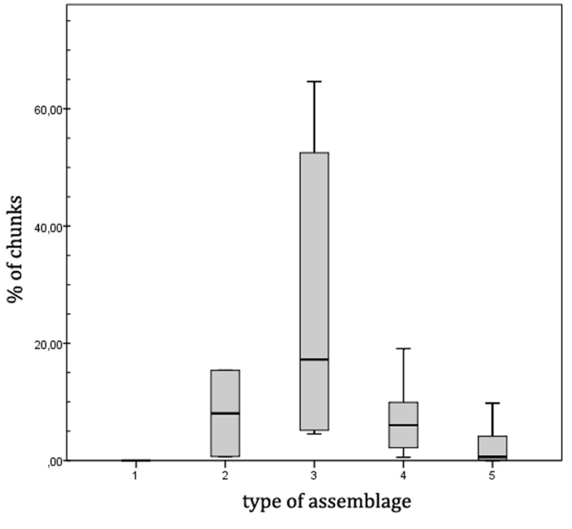


Fig. 4 Correlation between the quantity of chunks and the index of the quality of raw materials
Sl. 4 Odnos količine otpadaka i indeksa kvaliteta sirovine

The relationship between the quantity of chunks and the quality of knapped raw materials was examined by Spearman's rank correlation test, using I_{qrm} and the quantity of chunks. Raw materials were reported for quality and quantified by number of pieces only for 13 assemblages originating from two sites, Crvena stijena and Medena stijena. (fig. 5; Appendix 1). Additionally, we investigated whether more chunks is made of lower quality raw materials than of higher quality, employing Fisher's exact test to reveal relationship between artifact categories, grouped as chunk and not-chunk, and quality of raw materials, classified as higher and lower quality, all quantified by number of pieces. Only 8 assemblages from a single site (Crvena stijena) had all the data needed and were subjected to testing (Appendix 2).

In order to reveal skillful activity as formative factor of archaeological assemblages, there should be no statistically significant differences in the quantity of chunks among groups of functional types, and there should be no significant correlations between raw materials used and the quantity of chunks, so as between used raw materials and artifact categories.

All statistical tests were made using SPSS 18.0[2]. The alpha value for a significant effect was set at 0,05.

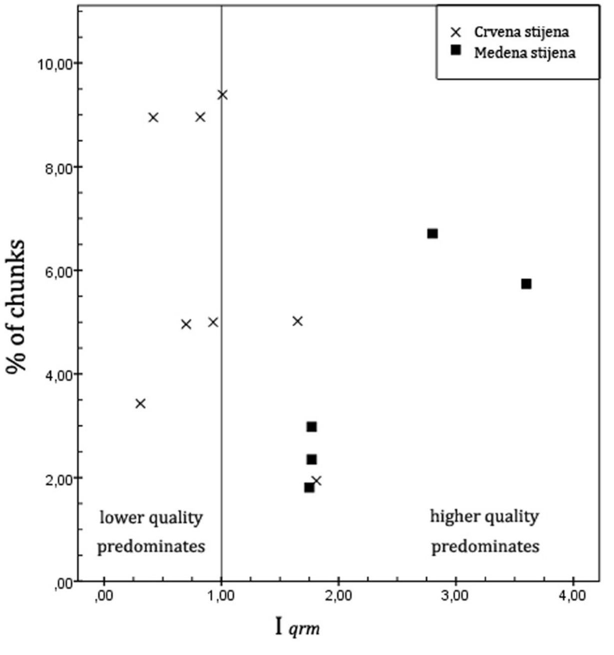


Fig. 5 Range of the quantity of chunks in different types of assemblages
Sl. 5 Obim količine otpadaka prema funkcionalnim tipovima skupova nalaza

[2] Statistical Package for the Social Sciences.

Results

… Just like a Skill

Size of the assemblage is excluded as factor affecting the quantity of chunks, since Pearson coefficient revealed no correlation between them r^2= ,216, p > ,05.

(1) There was statistically significant difference in the quantity of chunks among groups of diverse functional types of sites H(2)=9,563, *p*< ,01, with a mean rank of the quantity of chunks 17,33 for type 3 (N=12), 11,00 for type 4 (N=8) and 5,80 for type 5 (N=5) (fig. 4). Post-hoc tests for pairwise comparisons were conducted using Bonferroni's adjusted alpha levels of ,0167 per test (,05/3). Results showed statistically significant difference between groups 3 and 5 (U=4, *p*<,0167, *r* = -,16), but not between groups 3 and 4 (U=22, *p*>,0167, *r* = -,1) and between groups 4 and 5 (U=10, *p*>,1, *r* = -,11).

(2) Spearman's rank correlation coefficient did not show statistically significant correlation between I_{qrm} and the quantity of chunks ρ = - ,228, p >,1, (fig. 5).

(3) Fisher's exact tests showed significant association between the quality of raw materials and the artifact categories for 6 examined assemblages, *p*<,005 in all cases (Appendix 2). We calculated the odds ratio for chunk occurrence within every assemblage. The odds of an event are the probability of it occurring compared to the probability of it not occurring. By dividing the odds of chunk occurence (number of chunks divided by total number of artifacts) in low quality raw materials group by the odds of chunk occurence in higher quality raw materials group, we measured the efficacy of the quality of knapped raw materials. Based on the odds ratio, chunks were 3,5–8,35 times more likely to occur if knapping lower quality raw materials than if knapping higher quality raw materials. However, there was no significant correlation between the quality of raw materials and artifact categories for two tested assemblages, representing layers IVa and VII, *p* >,1, indicating that chunk incidence is not related to the quality of knapped stone.

Discussion and conclusions

Results of statistical tests showed that quantity of chunks at the site can be explained by functional type of the assemblage, however with weak effect (1). We can consider skillful performance as formative factor for higher proportion of chunks at the sites that evidence more knapping activities and closer to the raw material deposits, following Apel (2008) who related the degree of theoretical knowledge and practical know-how of past individuals with higher proportions of knapping errors at sites that are close to the extraction areas. On the other hand, it is possible that functional types employed in this study aren't distinctive enough to reveal greater statistical diversity.

There were ambiguous results regarding the correlation between the quality of raw materials and the quantity of chunks (2,3), however Fisher's exact tests run for every assemblage separately are more reliable, using the most detailed data. Greater incidence of chunks in assemblages from Medena stijena together with higher proportions of better quality raw materials might imply less skillful activity taking place (fig. 5), but not necessarily; it could evidence that raw materials were readily available, easily accessible and thus expediently used and knapped with less care. We cannot make conclusions with more certainty so far, because we do not know whether chunks are made of high quality raw materials at that site. Assemblages from Crvena stijena provided the most convincing evidence of skill of past people (3). Results revealing correlation between the raw materials quality and artifact categories are congruent with previous studies (e.g. Miller 1997). However, assemblages from layers IVa and VII show that chunk occurrence is not related to the properties of knapped material. Unskillful execution is plausible explanation, relying also on recent experimental research that has shown that properties of knapped artifacts do not depend on raw materials as much as on the knapper's expertise (Eren et al. 2011b). Harmand (2009, 94) came to similar conclusion studying lithic artifacts from two Late Pliocene sites of Lokalalei, demonstrating that the choice of raw materials does not explain the variation among artifact collections, and suggests diversity to be a consequence of hominine activities or differences in skill levels. Another evidence which indicates that knapping products are not purely related to the raw material used is represented by the Lower Palaeolithic collection of Korolevo site. It exhibits the special reduction technology with numerous chunk-cores and chunk-flakes, which is absent in younger collections even though the same raw material is used: poor quality andesite (Koulakovska et al. 2010),

Even if the presence of un-skillful activity is considered credible, this simplistic method cannot give an estimate to the number of knappers involved. Williams & Andrefsky (2011) showed that the performances of different knappers significantly influence measurable debitage characteristics that are easily misinterpreted as product of different technological traditions, and Foulds (2010) demonstrated the difficulties in ascertaining individual knappers and their sequences in the experimental assemblage, even if refitting is applied. In other words, the assemblage resulting from the activity of both experienced and novice knappers might give a result similar to that produced by a certain number of apprentices. This complex interplay of diverse factors is acknowledged but omitted in the study that is motivated by the intention to develop a simple, broadly applicable tool for skill recognition.

This research was not meant to advocate skill either as the only or the main cause of uncontrollable impacts on knapped material, there is an array of other possible explanations. This is also true for other researches of skill (e.g. greater symmetry or standardization of knapped products does not necessarily imply enhanced skill). Scale for the measurement of skill and variables for its assessment are set by researchers supposing the same present and past underlying principles for the determination of desirable properties of the end product or of the aim of knapping sequence. Modern concepts of western society are used as a starting point for investigating past activities, so other meanings and properties of the terms beautiful, usable, useful, valuable, efficient, waste etc. need to be questioned. The intentions and the choices made under specific sets of conditions are the result of cognitive processes of an individual who is set in a cultural milieu. I believe that behavioural patterns and uniformities in the sample of appropriate size are identifiable and meaningful, revealing particularities, and combined together with detailed single-cased or individual-level studies can reveal exciting results. This research is in frame of optimal foraging theory, supposing human behaviour as oriented towards maximizing gains with minimal input effort and loss. Other approaches would, therefore, provide differing results. It is only speculation so far, but after conducting appropriate and various analyses, we may be able to approach the question e.g. whether larger number of chunks than expected results from less skillful activity or some specific set of conditions and the sequence of events (just imagine an experienced knapper making a mistake accidently due to an external disturbance –by children, danger or purposely breaking rock because of being emotionally overwhelmed, etc.). In that case, some of the determinations need to be reconsidered, and the definition of chunk as a 'non-intentionally' created product might be expanded by '… and sometimes purposively made'.

Results are not easy to interpret, especially because of the small sample of data suitable for testing, but they are significant for making directions for future studies and pointing to some problems in lithic analyses.

Tests that were run here can be applied generally, using data that does not require detailed techno-typological artifact analysis. Although numerous variables affecting the assemblage and its analysis were neglected, even if their existence and impacts had already been recognized (Driscoll 2011), some results were obtained implying the necessity of the examination of diverse factors in more detail, in order to determine the scope of their influences and to quantify them.

Methodology employed in this study, although very schematic and simplistic in form is useful due to its adjustable and flexible nature, creating opportunities to use and apply additional analytical techniques to the process of controlling results and advancing the levels of certainty and outreach. It is designed for analyzing only general data on assemblage structure, including as large a number of units as possible, allowing assemblages to be tested within every culture, time period or technological tradition, thus providing tool for making comparisons between behavioural patterns among distinct communities and groups of people. That objective was not reached, stressing the need for consensus and the standardization of archaeological reports after general assemblage analysis. General conclusions cannot be drawn, but some insights are provided. Great opportunity in applying these tests is the possibility to draw attention to unusual cases, as for layers IVa and VII at Crvena stijena and collections from Medena stijena, but the presence of un-skillful activities cannot be taken as granted. Nothing distinguishes layers IVa and VII at Crvena stijena regarding other excavated material so far (unusual or symbolic objects, or evidence of ritual activities that could be supportive for assessing the learning processes in past with more certainty), and we do not know the outcrops for the raw materials at Medena stijena. This study set a frame for further direction of LUP and Mesolithic assemblage analyses in studied area, and the next step would be to ‘go and hunt the skill down’ by means of a comprehensive study with a more standardized approach so as to make comparison with other classes of archaeological remains and detailed analysis of special attributes of lithic artifacts.

There are numerous possibilities for advancing this study, either by improving understanding of diverse variables, or by introducing time variables, pairing it with a dynamic diachronic approach, or by focusing on personal stories and single events. Conclusions which arise from the results obtained via this method cannot be taken as final, but as a starting point for further research. The standardization of assemblage analyses and data reporting would also significantly both improve and widen the extent of the possibilities for statistically testing these hypotheses. Dream on…

area	site	layers/assemblages	industry	main references
The Iron Gates	Alibeg		Mesolithic	Păunescu 2001
	Climente I		LUP	Păunescu 2000
	Climente II		LUP/ Mesolithic	Păunescu 2000
	Ostrovul Banului	I-II	LUP/ Mesolithic	Păunescu 2000
	Padina	A1, A2	Mesolithic	Radovanović 1981
Greece	Klissoura cave	3, 5, 5a	Mesolithic	Kaczanowska et al. 2010
		II-IId	LUP	
	Cyclope cave		Mesolithic	Samspon et al. 2003
	Megalakkos	4	LUP	Sinclair, 1997, 1999
		6	LUP/ Mesolithic	
	Zaimis	III, IV**, VII**, VIII, IX	Mesolithic	Galanidou 2003
	Boïla	IV	Mesolithic	Kotjabopoulou et al. 1999
		II, IIIa, IIIb	LUP	
	Klithi	Q26	LUP	Adam 1999
	Kastritsa	1	LUP	Adam 1999
Albania	Konispol*	VIII, IX, X	LUP	Harrold et al. 1999
Montenegro	Crvena stijena	IVa, IVb1, IVb2, V, VI, VII	Mesolithic	Baković et al. 2009, Mihailović 2009
		VIII, IX	LUP	
	Medena stijena	IV	Mesolithic	Mihailović 1996
		V, VI, VII, VIII, IX**, X	LUP	
	Trebački Krš	Ia, Ib	Mesolithic	Đuričić 1996, Mihailović 1998
		II	LUP	
	Odmut *	XD, Ia, Ib	Mesolithic	Kozłowski et al. 1994
Dalmatia and hinterland	Badanj	6	LUP	Whallon 2007
	Vlakno	I, II, III	Mesolithic	Vukosavljević 2012
		I, II, III	LUP	
	Vela spila	A**, B**, C**, D**	Mesolithic	Vukosavljević 2012
		A**, B**, C, D, E, F, G, H, I**	LUP	
	Kopačina cave	I, II, III, IV	LUP	Vukosavljević 2012
Istria	Šandalja II	C/d, C/s, C/g**, C, B/C, B/d, B/s, B/g	LUP	Karavanić et al. 2013
	Šebrn Abri*		Mesolithic	Miracle et al. 2000

Total: 19 sites and 63 assemblages (37 LUP, 1 LUP/Mesolithic, 25 Mesolithic)

* not included in the analyses: Odmut – unknown quantity of chips and small pieces, Konispol – great number of shatter probably resulted of cave wall cracking as author pointed out, Šebrn Abri – lithic assemblage presented for the site as whole in spite of fact that faunal analyses pointed to at least two different settlements

** not included in the analyses due to the small size (less than 100 lithic pieces)

LUP – Late Upper Palaeolithic.

LUP/Mesolithic in the case of Megalakkos indicates both possibilities due to lack of absolute dates, and in the case of Climente II and Ostrovul Banului indicates that ssemblages were assigned to LUP in older literature but to the Early Mesolithic in recent literature

Fig. 6 List of sites and archaeological assemblages included in this study
Sl. 6 Spisak lokaliteta i arheoloških zbirki uključenih u ovu studiju

Appendix 1. Quantified data subjected to statistical testing

site	layer	assemblage size [a]	tools (%)	cores (%)	debitage (%)	chunks (%)	type [b]	*Iqrm* [c]
Alibeg		555	3,20	8,80	88,00	22,40		
Climente I		230	40,87	0,00	59,13	7,39		
Climente II		5864	9,18	5,79	85,03	40,54		
Ostrovul Banului	I-II	3593	7,48	3,68	88,84	64,64	3	
Padina	A1	414	23,67	15,70	60,63	17,87		
	A2	1544	15,16	22,73	62,11	18,39		
Boïla	II	1732	69,23	0,52	30,25	0,06		
	IIIa	3063	93,57	0,03	6,40	0,00		
	IIIb	5571	61,77	0,32	37,91	0,02		
	IV	6335	36,57	0,46	62,97	0,08	5	
Cyclope Cave		179	1,68	0,00	98,32	0,00	1	
Kastritsa	1	3844	2,63	2,71	94,67	0,68	2	
Klissoura	II-IId	3401	7,41	4,62	87,97	48,96	3	
	3	699	8,87	5,72	85,41	32,47		
	5	955	4,82	4,29	90,89	58,43	3	
	5a	2450	5,35	3,84	90,82	56,04	3	
Klithi	Q26	2854	5,78	1,40	92,82	13,56	3	
Megalakkos	4	536	39,55	7,46	52,99	0,00	5	
	6	996	47,69	20,88	31,43	0,10		
Zaimis	III	154	53,90	7,14	38,96	5,84		
	VIII	159	14,47	0,63	84,91	6,92	4	
	IX	252	18,25	4,37	77,38	5,16	4	
Crvena stijena	IX	852	12,91	5,05	82,04	9,39	4	1,01
	VIII	1083	15,05	5,72	79,22	8,96		0,82
	VII	360	9,17	3,61	87,22	5,00	3	0,93
	VI	625	8,96	4,64	86,40	4,96	3	0,7
	V	2418	9,68	5,58	84,74	3,43		0,31
	IVb2	760	4,34	3,29	92,37	8,95		0,42
	IVb1	837	13,98	7,53	78,49	5,02		1,65
	IVa	516	18,60	6,59	74,81	1,94		1,81
Medena stijena	X	164	15,85	10,98	73,17	6,71		2,8
	MS VIII	244	21,72	3,69	74,59	5,74		3,6
	VII	221	19,91	1,81	78,28	1,81		1,75
	VI	1575	19,24	2,73	78,03	2,35		1,77
	V	1242	16,59	3,30	80,11	2,98	4	1,77
	IV	735	10,88	1,77	87,35	5,31	3	
Trebački Krš	II	161	24,22	5,59	70,19	0,62	5	
	Ib	218	12,39	4,59	83,03	1,38	4	
	Ia	362	13,26	2,21	84,53	0,55	4	
Badanj		4483	9,15	1,43	89,43	4,55	3	
Kopačina cave	I	345	16,52	10,72	72,75	20,29		
	II	2362	12,49	13,46	74,05	25,23		

	III	3607	13,22	14,50	72,28	25,17	
	IV	1508	11,14	17,18	71,68	24,60	
Vela spila	LUP-C	218	30,28	7,80	61,93	4,13	5
	LUP-D	487	17,45	7,60	74,95	26,90	
	LUP-E	530	18,11	9,62	72,26	24,34	
	LUP-F	1155	20,35	10,22	69,44	17,84	
	LUP-G	2734	17,26	12,07	70,67	22,79	
	LUP-H	485	16,91	9,28	73,81	32,37	
Vlakno	LUP-III	1728	4,80	1,50	93,69	15,39	2
	LUP-II	779	7,19	3,85	88,96	25,03	3
	LUP-I	1299	9,47	7,01	83,53	25,94	
	mesolithic III	556	5,58	5,94	88,49	18,71	
	mesolithic II	2071	5,26	3,19	91,55	18,06	3
	mesolithic I	1531	5,16	1,96	92,88	16,39	3
Šandalja	C/s	118	17,80	5,08	77,12	9,32	
	C/d	626	21,41	3,51	75,08	8,63	
	C	286	23,43	3,50	73,08	9,79	5
	B/C	993	13,80	3,73	82,48	10,47	4
	B/d	1755	19,37	3,36	77,26	12,59	
	B/s	5183	15,65	4,71	79,64	19,10	4
	B/g	2233	19,57	4,12	76,31	19,57	

[a] chips, undeterminable and artifacts less than 1,5cm not counted

[b] assemblage type according to Kozłowski (1980)

[c] Index of quality of raw materials

Appendix 2. Contingency tables and Fisher's exact tests for Crvena stijena assemblages

layer		raw materials quality: lower	higher	total	p (two-sided)
CS IX	chunks	49	12	61	$p < ,001$
	other	314	354	668	odds ratio* = 4,6
	total	363	366	729	
CS VIII	chunks	68	9	77	$p < ,001$
	other	437	403	840	odds ratio = 6,97
	total	505	412	917	
CS VII	chunks	8	8	16	$p > ,5$
	other	168	158	326	
	total	176	166	342	
CS VI	chunks	22	3	25	$p < ,001$
	other	187	213	400	odds ratio = 8,35
	total	209	216	425	
CS V	chunks	64	4	68	$p < ,001$
	other	1446	467	1913	odds ratio = 5,17
	total	1510	471	1981	
CS IVa	chunks	4	2	6	$p > ,1$
	other	148	273	421	
	total	152	275	427	
CS IVb1	chunks	24	12	36	$p < ,001$
	other	265	464	729	odds ratio = 3,5
	total	289	476	765	
CS IVb2	chunks	45	5	50	$p < ,001$
	other	358	164	522	odds ratio = 4,12
	total	403	169	572	

*odds ratio - lower quality /higher quality raw material odds ratio for chunk occurence
other – including cores, tools and debitage without chunks

Acknowledgments

The research presented here was undertaken as part of the project Cultural changes and population migrations in the early Praehistory of the Central Balkans (Kulturne promene i populaciona kretanja u ranoj praistoriji centralnog Balkana, OI177023) funded by Ministry of Education, Science and Technological Development of the Republic of Serbia. I am grateful to the reviewer for valuable remarks, to Dušan Mihailović and Ljiljana Đuričić for discussions, and to Marko Porčić who provided invaluable comments and help regarding statistical test.

References:

Adam, E. 1997. To know and to have: Raw material availability and Upper Palaeolithic stone asemblage structure in Epirus, in: *Klithi: Palaeolithic settlement and quaternary landscapes in northwest Greece. Volume 2. Klithi in its local and regional setting,* Cambridge: McDonald Institute for Archaeological Research: 481–496

Adam, E. 1999. The Upper Palaeolithic stone industries of Epirus, in: G. N. Bailey, E. Adam, E. Panagopoulou, C. Perlès, K. Zachos (eds.), *The Palaeolithic Archaeology of Greece and Adjacent Areas. Proceedings of the ICOPAG Conference, Ioannina, September 1994 (1999*), London, British School at Athens Studies 3: 137–147.

Ahler, S.A. 2002. Appendix C: Chipped stone flaking debris and stone tool analytic methods, in: S. A. Ahler (ed.), *Prehistory on First Street NE: The archaeology of scattered village in Mandan, North Dacota,* Research contribution 40. Paleocultural research group, Flagstaff, AZ. Submitted to the city of Mandan, ND, and the North Dacota Department of Transportation, Bismarck: C.1–C.12.

Ahler, S.A., Feiler, E., Badorek, C., Smail, M. 2002. Stone tools and flaking debris, in S. A. Ahler (ed.), *Prehistory on First Street NE: The archaeology of scattered village in Mandan, North Dacota,* Research contribution 40. Paleocultural research group, Flagstaff, AZ. Submitted to the city of Mandan, ND, and the North Dacota Department of Transportation, Bismarck: 12.1–12.81.

Andrefsky, W. Jr. 2005. *Lithics: Macroscopic approaches to analysis. Second edition,* Cambridge: Cambridge University Press.

Apel, J. 2008. Knowledge, know-how and raw material: the production of Late Neolithic flint daggers in Scandinavia, *Journal of Archaeological Method and Theory* 15: 91–111.

Baković, M., Mihailović, B., Mihailović, D., Morley, M., Vušović-Lučić, Z., Whallon, R., Woodward, J. 2009. Crvena Stijena excavations 2004-2006, preliminary report, *Eurasian Prehistory* 6/1–2: 3–21.

Bertran, P., Lenoble, A., Todisco, D., Desrosiers, P. M., Sørensen, M. 2012. Particle size distribution of lithic assemblages and taphonomy of Palaeolithic sites, *Journal of Archaeological Science* 39: 3148–3166.

Bleed, P. 2008. Skill matters, *Journal of Archaeological Method and Theory* 15: 154–166.

Bril, B., Rein, R., Nonaka, T., Wenban-Smith, F., Dietrich, G. 2010. The role of expertise in tool use: Skill differences in functional action adaptations to task constraints, *Journal of Experimental Psychology: Human Perception and Performance* 36-4: 825–839.
Darmark, K. 2010. Measuring skill in the production of bifacial pressure flaked points : a multivariate approach using the flip-test, *Journal of Archaeological Science* 37-9: 2308–2315.
Delagnes, A., Roche, H. 2005. Late Pliocene hominid knapping skills: The case of Lokalalei 2C, West Turkana, Kenya, *Journal of Human Evolution* 48: 435–472.
Driscoll, K. 2011. Identifying and classifying vein quartz artefacts: an experiment conducted at the World Archaeological Congress, 2008. *Archaeometry* 53-6: 1280–1296.
Đuričić, Lj. 1996. The chipped stone industry from the rock-shelter of Trebački Krš, in: D. Srejović (ed.), *Prehistoric settlements in caves and rock-shelters of Serbia and Montenegro, Fascicule 1,* Belgrade: University of Belgrade, Faculty of Philosophy, Centre for Archaeological research: *:* 75–102.
Eren, M.I., Bruce, B.A., Sampson, G.C. 2011a. Middle Paleolithic skill level and the individual knapper: an experiment, *American Antiquity* 76-2: 229–251.
Eren, M.I., Lycett, S.J., Roos, C.I., Sampson, G.C. 2011b. Toolstone constraints on knapping skill: Levallois reduction with two different raw materials, *Journal of Achaeological Science* 38: 2731–2739.
Fergusson, J. 2008. The When, Where, and How of novices in craft production, *Journal of Archaeological Method and Theory* 15: 51–67.
Finlay, N. 2008. Blank concerns: Issues of skill and consistency in the replication of Scottish Later Mesolithic blades, *Journal of Archaeological Method and Theory* 15: 68–90.
Foulds, F.W.F. 2010. Investigating the individual? An experimental approach through lithic refitting, *Lithics: The journal of the Lithic Studies Society* 31: 6–19.
Geribàs, N., Mosquera, M., Vergès, J. M. 2010a. The gesture substratum of stone tool making: an experimental approach, *Annali dell'Università di Ferrara Museologia Scientifica e Naturalistica* 6: 155–162.
Geribàs, N., Mosquera, M., Vergès, J. M. 2010b. What novice knappers have to learn to become expert stone toolmakers, *Journal of Archaeological Science* 37: 2857–2870.
Harmand, S. 2009. Variability in Raw Material Selectivity at the Late Pliocene sites of Lokalalei, West Turkana, Kenya, in: E. Hovers, D. R. Braun (eds.), *Interdisciplinary Approaches to the Oldowan,* Springer Netherlands: 85–97.
Harrold F.B, Korkuti M.M, Ellwood B.B., Petruso K.M., Schuldenrein J. 1999. The Palaeolithic of southermost Albania, in: G. N. Bailey, E. Adam, E. Panagopoulou, C. Perlès, K. Zachos (eds.), *The Palaeolithic Archaeology of Greece and Adjacent Areas. Proceedings of the ICOPAG Conference, Ioannina, September 1994 (1999*), London, British School at Athens, Studies 3: 361–362.
Högberg, A. 2008. Playing with flint: Tracing a child's imitation of adult work in a lithic assemblage, *Journal of Archaeological Method and Theory* 15: 112–131.

Högberg, A., Larsson, L. 2011. Lithic technology and behavioural modernity: new results from the Still Bay site, Hollow Rock Shelter, Western Cape Province, South Africa, *Journal of Human Evolution* 61:133–155.
Ingold, T. 2000. *The perception of the environment: Essays in livelihood, dwelling, and skill*, London: Routledge.
Kaczanowska, M., Kozłowski , J. K., Sobczyk, K. 2010. Upper Palaeolithic human occupations and material culture at Klissoura Cave 1, in: J. K. Kozłowski, M. C. Stiner (eds.), *Klissoura Cave 1, Argolid, Greece: The Upper Palaeolithic sequence. Eurasian Prehistory* 7-2: 133–285.
Karavanić, I., Vukosavljević, N., Šošić Klindžić, R., Kurtanjek, D., Zupanič, D. 2013. The lithic and bone industries of the Epigravettian layers from Šandalja II near Pula, *Vjesnik za arheologiju i povijest dalmatinsku* 106: 7–73.
Kotjabopoulou, E., Panagopoulou, E., Adam, E. 1999. The Boïla rockshelter: further evidence of human activity in the Voïdomatis Gorge, in: G. N. Bailey, E. Adam, E. Panagopoulou, C. Perlès, K. Zachos (eds.), *The Palaeolithic Archaeology of Greece and Adjacent Areas. Proceedings of the ICOPAG Conference, Ioannina, September 1994 (1999*), London, British School at Athens, Studies 3: 197–210.
Koulakovska, L., Usik, V., Haesaerts, P. 2010. Early Paleolithic of Korolevo site (Transcarpathia, Ukraine), *Quaternary International* 223-224: 116–130.
Kozłowski, J.K. 1980. Technological and typological differentiation of lithic assemblages in the Upper Palaeolithic: an interpretation attempt, in: R. Schild (ed.), *Unconventional archaeology, new approaches and goals in Polish archaeology*, Wrocław, Zakład Narodowy im. Ossolińskich: 33–55.
Kozłowski, J.K. 2005. Paléolithique supérieur et Mésolithique en Méditerranée: cadre culturel, *L'antropologie* 109: 520–540.
Kozłowski, J. K. & Kozłowski, S.K. 1982. Lithic industries from the multi-layer Mesolithic site Vlasac in Yugoslavia, in J. K. Kozłowski (ed.), *Origin of the chipped stone industries of the early farming cultures in Balkans*, Kraków, Nakładem Uniwersytetu Jagiellońskiego: 11–109.
Kozłowski, J.K., Kozłowski, S.K., Radovanović, I. 1994. *Meso- and Neolithic Sequence from the Odmut Cave (Montenegro)*, Warszawa: Wydawnictwa Uniwersytetu Warszawskiego.
La Torre, I. de 2004. Omo revisited: Evaluating the technological skills of Pliocene Hominids, *Current Anthropology* 45: 439–465.
Lycett, S., Eren, M.I. 2013. Levallois economics: an examination of 'waste' production in experimentally produced Levallois reduction sequences, *Journal of Archaeological Science* 40: 2384–2392
Mihailović, D. 1996. Upper Palaeolithic and Mesolithic chipped stone industries from the rock-shelter of Medena Stijena, in: D. Srejović (ed.), *Prehistoric settlements in caves and rock-shelters of Serbia and Montenegro, Fascicule 1*, Belgrade, University of Belgrade, Faculty of Philosophy, Centre for Archaeological research: 9–60.
Mihailović, D. 1998. *Gornji paleolit i mezolit Crne Gore*, Doktorska disertacija, Beograd: Filozofski fakultet, Univerzitet u Beogradu.
Mihailović, D. 2009. *Upper Palaeolithic and Mesolithic chipped stone industries from*

Crvena Stijena, Belgrade, University, Faculty of Philosophy, Centre for Archaeological Research,
Miller, R. 1997. Variability in lithic assemblages across space: differential responses to raw material context, *Notae Praehistoricae* 17: 53–62.
Miracle, P.T, Galanidou, N., Forenbaher. S. 2000. Pioneers in the hills: Early Mesolithic foragers at Šebrn Abri (Istria, Croatia), *European Journal of Archaeology* 3-3: 293–329.
Nonaka, T., Bril, B., Rein, R. 2010. How do stone knappers predict and control the outcome of flaking? Implications for understanding early stone tool technology, *Journal of Human Evolution* 59: 155–167.
Olausson, D.J. 2008. Does practice make perfect? Craft expertise as a factor in aggrandizer strategies, *Journal of Archaeological Method and Theory* 15: 28–50.
Păunescu, A. 2000. *Paleoliticul și mezoliticul din spaţiul cuprins între Carpaţi și Dunăre.* București: Editura Agir.
Păunescu, A. 2001. *Paleoliticul şi mezoliticul din spaţiul Transilvănean*. Bucureşti: Editura Agir.
Radovanović , I. 1981. *Padina : ranoholocenska kremena industrija sa lokaliteta Padina u Đerdapu*, Beograd : Arheološki institute.
Rein, B., Bril, B., Nonaka, T. 2013. Coordination strategies used in stone knapping, *American Journal of Physical Anthropology* 150-4: 539–550.
Roubet, C. 1997. The lithic domain at Klithi: technology of production and the *chaîne opératoire*, in: G. Bailey (ed.), *Klithi: Palaeolithic settlement and quaternary landscapes in northwest Greece. Volume 1. Excavation and intra-site analysis ad Klithi*, Cambridge, McDonald Institute for Archaeological Research: 125–153.
Roux, V., Bril, B., Dietrich, G. 1995. Skills and learning difficulties involved in stone knapping: the case of stone-bead knapping in Khambhat, India, *World Archaeology* 27-1: 63–87.
Roux, V. & David, E. 2005. Planning abilities as a dynamic perceptual-motor skill: an actualist study of different levels of expertise involved in stone knapping, in: V. Roux, B. Bril (eds.). *Stone knapping : the necessary conditions for a uniquely hominin behaviour*, Cambridge, McDonald Institute Monographs: 91–108.
Sampson, A., Kozłowski, J.K. & Koczanowska, M. 2003. Mesolithic chipped stone industries from the Cave of Cyclope on the island of Youra (northern Sporades), in: N. Galanidou, C. Perlès (eds.): *The Greek Mesolithic: problems and perspectives*, London, British school at Athens, Studies 10: 123–130.
Sinclair, A. 1997. Lithic and faunal assemblages from Megalakkos: some problems in the interpretation of small sites, in: G. Bailey (ed.), *Klithi: Palaeolithic settlement and quaternary landscapes in northwest Greece. Volume 2. Klithi in its local and regional setting*, Cambridge, McDonald Institute for Archaeological Research: 415–425.
Sinclair, A. 1999. Technological decision making and the influence of specialised activities: the case of Megalakkos (Epirus, Greece), in: G. N. Bailey, E. Adam, E. Panagopoulou, C. Perlès, K. Zachos (eds.), *The Palaeolithic Archaeology of Greece and Adjacent Areas* (*Proceedings of the First International Conference on the Palaeolithic Archaeology of Greece and Adjacent Areas, Ioannina, September 1994*), London, Brit-

ish School at Athens, Studies 3: 188–198.
Stapert, D. 2007. Neanderthal children and their flints, *PalArch's Journal of Archaeology of Northwest Europe* 1, 2: 16–39.
Stout, D. 2002. Skill and cognition in stone tool production: an ethnographic case study from Irian Jaya, *Current Anthropology* 43-5: 693–722.
Stout, D., Schick K., Toth N. 2009. Understanding Oldowan knapping skill: an experimental study of skill acquisition in modern humans, in: K. Schick, N. Toth (eds.), *The cutting edge: new approaches in the archaeology of human origins*, Gosport, IN, Stone Age Institute Press: 247–266.
Stout, D., Passingham, R., Frith, C., Apel, J., Chaminade, T. 2011. Technology, expertise and social cognition in human evolution, *European Journal of Neuroscience* 33: 1328–1338.
Tostevin, G. 2011. Levels of theory and social practice in the reduction sequence and *chaîne opératoire* methods of lithic analysis, *PaleoAnthropology*: 351–375.
Vukosavljević, N. 2012. *Organizacija litičke proizvodnje lovačko sakupljačkih zajednica na prijelazu iz pleistocena u holocen u Dalmaciji*, Doktorska disertacija, Zagreb: Filozofski fakultet, Sveučilište u Zagrebu.
Vukosavljević, N., Perhoč, Z., Čečuk, B., Karavanić, I. 2011. Late Glacial knapped stone industry of Kopačina cave, *Vjesnik za arheologiju i povijest dalmatinsku* 104: 7–54.
Whallon, R. 2007. Spatial distributions and activities in Epigravettian level 6 at the site of Badanj, Bosnia and Herzegovina, *Гласник Српског археолошког друштва* 23: 9–26.
Whiten, A., Schick, K., Toth, N. 2009. The evolution and cultural transmission of percussive technology: integrating evidence from paleoanthropology and primatology, *Journal of Human Evolution* 57: 420–435.
Wickham-Jones, C. R. 2004. Glossary and notes to the lithic catalogue, *Scottish Archaeological Internet Reports* 12: 69–71.
Williams, J. P., Andrefsky, W. Jr. 2011. Debitage variability among multiple flint knappers, *Journal of Archaeological Science* 38: 865–872.
Wynn, T., Coolidge, F. L. 2004. The expert Neandertal mind, *Journal of Human Evolution* 46: 467–487.

Milica Lopičić
Univerzitet u Beogradu, Filozofski fakultet – Odeljenje za arheologiju

PROĆERDANA VEŠTINA: FENOMEN OTPADAKA

Veština obuhvata fizičke i kognitivne sposobnosti pojedinca koji izrađuje predmet, i odslikava se u proizvodu. Arheološka istraživanja, analizirajući artefakte i druge materijalne ostatke iz prošlosti, razmatraju veštinu sa namerom da procene motorne i mentalne sposobnosti ljudi koji ne pripadaju savremenom čoveku, ili prepoznaju pojedince u arheološkom skupu nalaza, i rekonstruišu društvene odnose i ponašanje.

Veština podrazumeva posedovanje neophodnog teorijskog znanja o zadatku kojeg treba ispuniti, i tehničke sposobnosti, odnosno spretnosti da se zadati cilj ostvari (Apel 2008; Finlay 2008). Tehničko umeće (položaj tela, gestovi, jačina udarca) razvija se uvežbavanjem pokreta, odnosno ponavljanjem aktivnosti. Tom prilikom se primenjuje teorijsko znanje o pokretima tela i ponašanju materijala, a istovremeno se ažurira i proširuje. Takve suptilne promene u veštini nisu odmah uočljive, čak i ne rezultuju uvek uspehom u izvršenju zadatka, ali se sticanje veštine može predstaviti kao progresivna linija koja izražava srednju vrednost između broja uspešnih i neuspešnih zadataka tokom određenog vremenskog perioda (sl. 1). Eksperimentalna istraživanja potvrdila su da se veština može sagledati i izraziti kroz različite merljive parametre, koji opisuju samu aktivnost (pojedinačne pokrete, donošenje odluka), ili karakterišu proizvode okresivanja; odnosno da se mogu porediti i razlikovati skupovi artefakata koje izrade pojedinci različitih ekspertskih nivoa (Bril et al. 2010; Geribàs et al. 2010a; Rein et al. 2013; Darmark 2011; Eren et al 2011a; La Torre 2004; Apel 2008). Detaljne analize pojedinih atributa arheoloških ostataka omogućavaju prepoznavanje manje i više veštih aktivnosti. Međutim, dobijeni rezultati isključuju međusobna kvantitativna poređenja, jer se najčešće svaki skup proučava posebno razvijenim metodom. Javila se potreba za primenom opštijeg metoda za procenjivanje veštine ljudi iz prošlosti, čiji je razvoj otežan usled nepoznatih efekata brojnih pre-depozicionih i post-depozicionih činilaca na formiranje arheoloških skupova nalaza. Radi ispitivanja pretpostavke da se veština može uočiti u zbirkama artefakata okresanog kamena kao stvaralački faktor, sagledani su uticaji drugih faktora na karakteristike skupova.

Nedostatak veštine je, sa tehničkog aspekta, okarakterisan kao nekontrolisan udarac na komad sirovine, i kvantifikovan kao količina nepravilnih neretuširanih proizvoda okresivanja, tj. otpadaka (Ahler et al. 2005;

Stout et al. 2009; Andrefsky 2005). Količina otpadaka u skupu nalaza zavisi i od drugih činilaca osim veštine ljudi koji su okresivali, naročito od kvaliteta sirovine i funkcije lokaliteta: više otpadaka nastaje usled upotrebe manje kvalitetne sirovine, i veću količinu otpadaka sadrže arheološki skupovi sa odlikama radioničkih aktivnosti, naročito u blizini ležišta (u odnosu na manje otpadaka na lokalitetima svakodnevnih ili specijalizovanih lovnih aktivnosti). Testirane su korelacije između ovih varijabli kako bi se indirektno razmotrila mogućnost uočavanja uticaja veštine. Korišćeni su podaci o objavljenim opštim strukturama skupova nalaza i sirovinama sa lokaliteta kasnog gornjeg paleolita i mezolita na Balkanskom poluostrvu (sl. 6). Funkcija lokaliteta određena je prema kriterijumima koje je predložio Kozłowski (1980). Sirovine su podeljene u dve kategorije, kvalitetnije i manje kvalitetne, prema komentarima istraživača koji su analizirali skupove. Izračunat je njihov odnos meren brojem artefakata i izražen kao indeks I_{qrm} (Appendix 1).

Statistički testovi pokazali su da postoji razlika u količini otpadaka (merena brojem a ne masom artefakata) između različitih funkcionalnih tipova skupova, ali da ne postoji veza između količine otpadaka i zastupljenosti sirovine slabijeg kvaliteta u skupovima nalaza (sl. 4, 5). Sa druge strane, ispitivanje veze između nastajanja otpadaka i kvaliteta okresivane sirovine, koje je zbog prirode podataka bilo moguće izvršiti samo na objavljenim podacima o skupovima nalaza sa lokaliteta Crvena stijena (Mihailović 2009), pokazalo je da je pojava otpadaka u vezi sa upotrebom sirovine lošijeg kvaliteta (Appendix 2). Ipak, dva analizirana skupa, iz slojeva VII i IVa Crvene stijene ne pokazuju povezanost kvaliteta sirovine i nastajanja otpadaka.

Rezultati analize ukazuju da se količina otpadaka u određenoj meri može objasniti funkcionalnim tipom skupa, odnosno aktivnostima koje su se odvijale na lokalitetu i njegovom ulogom u sistemu naseljavanja. Nepostojanje veze između kvaliteta sirovine u skupu nalaza i količine otpadaka može se objasniti nalazima sa lokaliteta Medena stijena (sl. 2) gde raste količina otpada sa većom zastupljenošću kvalitetnije sirovine. Takva pojava ne ukazuje nužno na nedostatak veštine osoba koje su okresivale, jer moguće je da su kvalitetne sirovine bile lako dostupne i kao takve nemarno obrađivane. Nemamo podatke o blizini ležišta, i za sada ne možemo detaljnije razmotriti skupove artefakata iz Medene stijene. Najuverljivija svedočanstva o veštini kao činiocu koji utiče na strukturu zbirke ostataka okresanih artefakata pružili su nalazi sa lokaliteta Crvena stijena. U većini skupova potvrđena je povezanost upotrebe sirovine slabijeg kvaliteta i nastanka otpadaka, međutim dva skupa pokazuju da pojava otpadaka ne zavisi od kvaliteta okresivane sirovine i pružaju mogućnost da se razmotre kao ostaci ne-veštih aktivnosti. Nedostatak veštine osoba koje su okresivale, ukazivao bi na njihov uzrast i na posebno mesto lokaliteta, gde se odvijalo učenje i prenošenje znanja (c.f. Apel 2008). Ipak, slojevi VII i IVa se ne razlikuju od ostalih slojeva sa lokaliteta prema drugim nalazima (neobični ili simbolički predmeti, ili svedočanstva o ritualnim aktivnostima) koji bi podržali tumačenje kamenih artefakata kao ostataka procesa podučavanja i nedostatka veštine.

Zaključci dobijeni ovim istraživanjem ne mogu se smatrati konačnim, već kao osnova za dalja istraživanja i unapređivanje testova, razumevanjem uticaja neispitanih činilaca, ili uvođenjem vremenske varijable. Ipak, predstavljeni testovi su značajni jer koriste opšte podatke o strukturama skupova artefakata okresanog kamena što dozvoljava njihovu široku primenu nezavisno od kulturne atribucije i geografskog okvira. Posebno je zanimljiva mogućnost izdvajanja neobičnih slučajeva, čime se stvaraju okviri za dalje detaljnija istraživanja. Standardizacija analize artefakata okresanog kamena i objavljivanje rezultata svakako bi proširilo i poboljšalo mogućnosti za statističke provere hipoteza.