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Članak donosi rezultate litičke analize kamenih artefakata otkrivenih tijekom višegodišnjih iskopavanja u pećini Kopačini (1978.-1993.). Učestalost pločica s hrptom i zakrivljenih šiljaka s hrptom bio je kriterij za izdvajanje dviju litičkih faza, starije, litičke faze I, i mlađe, litičke faze II. Na temelju apsolutnih datuma i litičke analize ovdje je predloženo drugačije tumačenje kulturne stratigrafije (kasni gornji paleolitik, brončano doba) u odnosu na prethodna tumačenja (kasni gornji paleolitik, mezolitik, brončano doba). Tehnološki i tipološki Kopačina pokazuje znatnu sličnost s kasnoglacijalnim industrijama Vele spile i Badnja. Mikroskopskom i makroskopskom analizom dijela litičkog skupa nalaza definirano je osam petrografskih skupina, među kojima dominira skupina lokalnog mikritnog rožnjaka. Skupina crvenog i zelenog radiolarita, iako malobrojna, indikator je povezanosti

The article presents the results of a lithic analysis of stone artefacts discovered over the course of multiple years of excavations in Kopačina Cave (1978-1993). The frequency of backed bladelets and curved backed points served as the criteria for distinguishing between two phases: the older, lithic phase I and the younger lithic phase II. Based on the absolute dates and the lithic analysis, an interpretation of the cultural stratigraphy (late Upper Palaeolithic, Bronze Age) is proposed here which differs from prior interpretations (late Upper Palaeolithic, Mesolithic, Bronze Age). In terms of technology and typology, Kopačina exhibits considerable similarity to the Late Glacial industries of Vela Spila and Badanj. Microscopic and macroscopic analysis of a portion of the lithics set of finds has facilitated the definition of 8 petrographic groups, among which the group of local micritic cherts dominates. The group of red and green radiolarites, although few in number, is

kopačinskih lovaca i skupljača s dubokim istočnojadranskim zaleđem. U cijelom stratitigrafskom slijedu postoji sličan obrazac iskorištavanja sirovine.

Ključne riječi: kasni glacijal, litička analiza, Kopačina, epigravetijen, sirovina, petrografska analiza, kulturna stratigrafija

an indicator of the ties between the Kopačina hunter-gatherers and the deep Eastern Adriatic hinterland. There is a similar pattern of raw materials use running through the entire stratigraphic sequence.

Key words: Late Glacial period, lithic analysis, Kopačina, Epigravettian, raw material, petrographic analysis, cultural stratigraphy

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1. Uvod

Arheološki podaci o boravku čovjeka tijekom kasnog glacijala u Dalmaciji poprilično su rijetki. Postoji svega nekoliko nalazišta datiranih u to vrijeme (npr. Vela spila na Korčuli, Vlakno na Dugom otoku, Kopačina na Braču, Zemunica). Broj nalazišta nešto je veći uzmemo li u obzir cijelu istočnojadransku obalu i njezino zaleđe (Šandalja II, Vešanska pećina, Nugljanska pećina, Pupićina pećina, Badanj, Crvena stijena, Medena stijena, Mališina stijena, Trebački krš). Usporedi li se arheološka slika kasnoga gornjeg paleolitika s ranijim razdobljima gornjeg paleolitika i srednjeg paleolitika, razvidno je da su nalazišta brojnija i ukazuju na intezivnije naseljavanje ovog prostora tijekom kasnoga glacijala.[1] Sva nalazišta iz tog vremena su pećinska, a lokaliteti na otvorenom gotovo su nam potpuno nepoznati osim nekoliko površinskih koncentracija, ali je njihova kulturno-kronološka atribucija upitna. Malobrojnost nalazišta u Dalmaciji iz tog vremena može biti povezana s podizanjem morske razine i potapanjem potencijalnih nalazišta, recentnim kultiviranjem terena, kao i sa slabim intenzitetom istraživanja na ovom prostoru.

U članku se prvi put objavljuju kvantitativni rezultati litičke analize cjelokupnog skupa nalaza iz Kopačine. Analizom litičkog skupa nalaza iz Kopačine pokušat ćemo proširiti naše spoznaje o ovoj poprilično slabo dokumentiranoj fazi ljudskog boravka u Dalmaciji, a usporedbom kopačinske litičke industrije s približno istovremenim industrijama na istočnojadranskoj obali i u njezinom zaleđu, dobit ćemo jasniju sliku prostorne distribucije regionalnih sličnosti i razlika vremenski srodnih industrija. Osim tehno-tipološke analize provedena je i petroarheološka analiza litičkog inventara koja je poduzeta u okviru istraživanja nabave sirovine u prapovijesnoj litičkoj industriji u srednjoj Dalmaciji.[2] Prilikom pripremnog pregleda inventara zapažena je sličnost dijela kopačinske litike i velospilske s Korčule, a zatim, prema informacijama koje treba još potvrditi, i litike istodobnog nalazišta Badanj kod Stoca u istočnoj Hercegovini i to je poticaj za daljnje istraživanje povezanosti populacija ovih lokaliteta.[3] Ustanovljena nelokalna provenijencija pojedinih kopačinskih i velospilskih petrografskih tipova, bila je dodatan razlog za sustavnu analizu litičkog inventara ovog prapovijesnog nalazišta, pa je 2007. i 2008. godine obavljena petrografska klasifikacija dijela iskopanih nalaza iz istraživanja provedenih između 1978. i 1993. godine. Pri izboru uzorka vodilo se računa da se pokrije cjelokupni stratigrafski slijed, od najplićih do najdubljih slojeva.

Ovo je prvi izvještaj o porijeklu kamena korištenog za izradu litičkih artefakata iz pećine Kopačine. Naše istraživanje izvora sirovine u prapovijesnoj litičkoj industriji srednje Dalmacije vrlo brzo je nadišlo svoj radni okvir, dugoročno je i kompleksno već samim time što je litički inventar svih do sada poznatih litičkih

1 Kozlowski 1999, str. 322; Mihailović 1999, str. 385.
2 Perhoč 2009a; Perhoč 2009b.
3 Zahvaljujemo arheologu Damiru Kliškiću iz Arheološkog muzeja u Splitu za nalaze ustupljene na pregled.

1. Introduction

Archaeological data on human habitation in Dalmatia during the Late Glacial period are rather meagre. There are several sites dated to this time (e.g. Vela Spila on the island of Korčula, Vlakno on the island of Dugi otok, Kopačina on the island of Brač, Zemunica). The number of sites increases somewhat if the entire Eastern Adriatic seaboard and its hinterland are considered (Šandalja II, Vešanska pećina, Nugljanska pećina, Pupićina pećina, Badanj, Crvena stijena, Medena stijena, Mališina stijena, Trebački krš). A comparison of the archaeological picture of the late Upper Palaeolithic with earlier periods of the Upper and Middle Palaeolithic shows that the sites are more numerous and indicate more intensive settlement of this area during the Late Glacial period.[1] All sites from this period are caves, while outdoor sites are virtually unknown except for a few surface concentrations, but their cultural/chronological attribution is tenuous. The small number of sites in Dalmatia from this period may be linked to rising sea levels and the flooding of potential sites, and more recent soil cultivation, but also the rather low intensity of research in this region.

In this article, the quantitative results of lithic analysis of the entire assemblage from Kopačina are published for the first time. Through an analysis of the lithic finds from Kopačina, we shall endeavour to expand our knowledge of this rather poorly documented phase of human habitation in Dalmatia, while a comparison of the Kopačina lithic industry with chronologically approximately contemporary industries on the Eastern Adriatic and its hinterland will provide a clearer picture of the spatial distribution of regional similarities and differences of chronologically related industries. Besides a techno-typological analysis, a petrographic analysis of the lithic assemblage was also conducted within the framework of research into the procurement of raw materials in the prehistoric lithic industry in central Dalmatia.[2] During a preliminary examination of the inventory, a similarity was noted between some of the Kopačina lithics and Vela Spila lithics from Korčula, and subsequently - based on information which has yet to be confirmed - the lithics from Badanj site near Stolac, in eastern Herzegovina. This served as the impetus for further research into the links between the populations of this sites.[3] The established extra-local provenance of individual Kopačina and Vela Spila petrographic types served as an added reason for systematic analysis of the lithic inventory of this prehistoric site, so in 2007 and 2008 a petrographic classification was made for a portion of the finds excavated during research conducted between 1978 and 1993. During sampling due attention was paid to encompass the entire stratigraphic sequence, from the shallowest to the the deepest layers.

This is the first report on the origin of the stone used to make the lithic artefacts from Kopačina Cave. Our research into the sources of the raw materials for the lithic industry of central Dalmatia very quickly exceeded its operative framework, for it is long-term and complex simply because the lithic inventory of all thus-far known

1 Kozlowski 1999, p. 322; Mihailović 1999, p. 385.
2 Perhoč 2009a; 2009b.
3 We would like to thank archaeologist Damir Kliškić from the Archaeological Museum in Split for the finds he allowed us to examine.

prapovijesnih inventara šire petrografije negoli su to lokalni izvori korištenog kamena iz skupine sedimentnih silicijskih stijena. Stoga je svrha ovog izvještaja ukazati na moguće porijeklo kamena kopačinskih artefakata, tj. na ležišta i izdanke korištenih stijena, a cilj prilog rekonstrukciji ekonomije nabave litičke sirovine, time i mreže kretanja kopačinske populacije u kasnoglacijalnom okolišu.[4]

2. Geografski položaj i povijest istraživanja

Pećina Kopačina smještena je na sjeverozapadnoj strani otoka Brača, između Supetra i Donjeg Humca, na nadmorskoj visini od 280 m (43°22' N i 16°32 E). Orijentirana je prema zapadu.[5] Tijekom kasnoga glacijala Kopačina je kontrolirala moguću rutu ungulata između Nerežiškog i Dračevskog polja, s jedne strane, i Jadranske ravnice, s druge strane.[6]

Prva istraživanja u Kopačini poduzeli su F. Bulić i J. Szombathy 1891. godine, kao dio pokusnih istraživanja prapovijesnih pećina i gomila na otoku Braču. Otkopani su slojevi do dubine 50-60 cm i zabilježeni su ulomci prapovijesne keramike, kostiju i puževa, kao i dva rožnjačka artefakta.[7] Na istome mjestu Bulić navodi i površinske nalaze rožnjačkih artefakata u okolici crkve sv. Ilije, kao i u mjestu Banja, zapadno od crkve.

D. Vrsalović poduzeo je također pokusna istraživanja 1958. godine, ali u prednjem dijelu pećine.[8] Pronađene arheološke ostatke smješta u široki vremenski okvir, od mezolitika do kraja trećeg tisućljeća prije Krista.[9]

Sustavna arheološka istraživanja u Kopačini provođena su od 1978. do 1993. godine pod vodstvom B. Čečuka. Iskopavanja su provedena u prednjem i stražnjem dijelu pećine. Tijekom iskopavanja B. Čečuk je u nekoliko navrata sumarno izvještavao o tijeku istraživanja i pronađenim ostacima materijalne kulture,[10] a nakon završetka istraživanja isti autor je ukratko prikazao dotadašnje spoznaje o pećini Kopačini.[11]

Odnedavno se ponovno provode istraživanja u Kopačini pod vodstvom D. Kliškića.[12] Iako su istraživanja u Kopačini

prehistoric lithics inventories constitute a broader petrography than the local sources of stone used from the group of sedimentary siliceous rock. Thus, the purpose of this report is to highlight the possible origin of the stone for the Kopačina artefacts, i.e. the deposits and outcrops of used rock, and the objective of this article is to reconstruct the economy underlying procurement of lithic raw materials, and thereby the network in which the Kopačina population moved in the Late Glacial environment.[4]

2. Geographic position and research history

Kopačina Cave is situated on the north-west side of the island of Brač, between Supetar and Donji Humac, at an elevation of 280 m (43°22' N and 16°32 E). It has a westward orientation.[5] During the Late Glacial period, Kopačina overlooked a possible route of ungulates between the Nerežišće and Dračevica fields on one side and the Adriatic plain on the other.[6]

The first research conducted in Kopačina was undertaken by F. Bulić and J. Szombathy in 1891, as a part of test research into prehistoric caves and mounds on Brač. Layers down to a level of 50-60 cm were excavated, and fragments of prehistoric pottery, bones and snail shells, as well as two chert artefacts, were recorded.[7] At the same site, Bulić also cited surface finds of chert artefacts around the Church of St. Elias, and in the village of Banja, west of this church.

D. Vrsalović also conducted test research in 1958, but in the frontal portion of the cave.[8] The discovered archaeological remains were classified over a broad chronological framework, from the Mesolithic to the end of the third millennium BC.[9]

Systematic archaeological research in Kopačina was conducted from 1978 to 1993 under the leadership of B. Čečuk. Excavations were conducted in the front and rear of the cave. During excavations, Čečuk compiled summary reports on the course of research and the remains of material culture found there,[10] and after the conclusion of research, he compiled a brief overview of all previous knowledge of Kopačina Cave.[11]

Recently research in Kopačina resumed under the leadership of D. Kliškić.[12] Even though research in Kopačina has been conducted

4 U kasnom pleistocenu Brač je bio povezan s obalom (uzak pojas recentne dubine 24 m na liniji Split - Splitska vrata, mogao je biti najkasnija veza otoka s kopnom). S porastom razine Jadrana Brač početkom holocena postaje otokom (procjena prema Surić 2006, str. 169 i Batimetrijskoj karti Jadrana 1994).
5 Za detaljan opis špilje vidi Čečuk 1981, str. 10, bilj. 2 i Miracle 1995, str. 68.
6 Miracle 1995, str. 67. Jadranska ravnica je kopno nastalo spuštanjem morske razine tijekom pleistocenskih oledbi na mjestu današnjega Jadranskog mora.
7 Bulić 1891, str. 17, 18.
8 Prema Vrsaloviću 1960, str. 36, Bulić i Szombathy iskopavali su u unutrašnjem dijelu pećine.
9 Vrsalović 1960, str. 36, 37, 40; istražena je površina 2 x 1,5 m do dubine od 1,2 m.
10 Čečuk 1981; Čečuk 1982; Čečuk 1985; Čečuk 1986a; Čečuk 1986b; Čečuk 1987; Čečuk 1989a; Čečuk 1989b; Čečuk 1990; Čečuk 1991; Čečuk 1992; Čečuk 1993.
11 Čečuk 1996.
12 Kliškić 2007; Kliškić 2008.

4 In the late Pleistocene, Brač was linked to the coast (a narrow isthmus with a recent depth of 24 m on the Split-Split Gate line may have been the most recent link between the island and the mainland). When the Adriatic's level rose in the early Holocene, Brač became an island (estimate based on Surić 2006, p.169 and the Bathymetric Map of the Adriatic, 1994).
5 For a detailed description of the cave, see Čečuk 1981, p. 10, note 2 and Miracle 1995, p. 68.
6 Miracle 1995, p. 67. The Adriatic plain is a tract which emerged when the sea level declined during the Pleistocene glaciation at the site of today's Adriatic Sea.
7 Bulić 1891, p. 17, 18.
8 Based on Vrsalović 1960, p. 36, Bulić and Szombathy dug in the cave's interior.
9 Vrsalović 1960, pp. 36-37, 40; Researched surface is 2 x 1.5 m to a depth of 1.2 m.
10 Čečuk 1981; 1982; 1985; 1986a; 1986b; 1987; 1989a; 1989b; 1990; 1991; 1992; 1993.
11 Čečuk 1996.
12 Kliškić 2007; 2008.

Lab. No.	BP	cal BC (1 σ)	cal BC (2 σ)	Materijal	Položaj	Dubina (cm)
Z-2403	13160 ± 310	14630 - 13310	14960 - 12960	kost	D1-C1/7	140-160
Z-2404	11980 ± 270	12240 - 11490	12960 - 11360	kost	C1-A/5-6	20-40
Z-778	9160 ± 100	8540 - 8280	8700 - 8220	kućica kopnenog puža	nepoznato	nepoznato
Z-776	5340 ± 65	4260 - 4050	4340 - 4000	travertin	nepoznato	nepoznato

Tablica 1.
Radiokarbonski datumi iz pećine Kopačine[13]

Lab. No.	BP	cal BC (1 σ)	cal BC (2 σ)	Material	Site	Depth (cm)
Z-2403	13160 ± 310	14630 - 13310	14960 - 12960	bone	D1-C1/7	140-160
Z-2404	11980 ± 270	12240 - 11490	12960 - 11360	bone	C1-A/5-6	20-40
Z-778	9160 ± 100	8540 - 8280	8700 - 8220	terrestrial snail shell	unknown	unknown
Z-776	5340 ± 65	4260 - 4050	4340 - 4000	travertine	unknown	unknown

Table 1.
Radiocarbon dates from Kopačina Cave[13]

provođena dugi niz godina, izostala je sustavna objava iskopanog arheološkog materijala. Iznimka je zooarheološka obrada pronađenih faunističkih ostataka.[14]

3. Kulturna stratigrafija i apsolutna kronologija

Kulturna stratigrafija Kopačine, prema dostupnim podacima, može se podijeliti u tri velike cjeline: brončano doba, mezolitik i kasni gornji paleolitik. Ovakav stratigrafski slijed zabilježen je samo u unutrašnjem dijelu, dok u prednjem dijelu pećine nema brončanodobnih ostataka.[15] Zbog nemogućnosti i teškoća pri praćenju i odvajanju slojeva koji pripadaju kasnom gornjem paleolitiku od onih koji pripadaju mezolitiku,[16] slojevi su iskopavani arbitrarno u debljini od 15-20 cm, a dubine su mjerene u odnosu na postojeću pećinsku hodnu površinu.[17] Uzimajući u obzir nagnutost pećinskog tla,[18] a samim time i nataloženih slojeva, i metodologiju iskopavanja, moralo je doći do stanovitog miješanja različitih geoloških i/ili arheoloških slojeva tijekom arbitrarnog iskopavanja slojeva.[19] Iskopani sediment nije prosijavan.

Na temelju radiokarbonskog datiranja kulturni ostaci iz Kopačine pripisani su kasnom glacijalu i ranom holocenu (preborealu), a jedan datum pripada razdoblju Atlantika (tablica 1).

over the course of many years, systematic publication of the excavated archaeological material has been lacking. The exception is zooarchaeological analysis of the animal remains.[14]

3. Cultural stratigraphy and absolute chronology

The cultural stratigraphy of Kopačina, according to available data, may be divided into three large units: the Bronze Age, the Mesolithic and the late Upper Palaeolithic. This stratigraphic sequence was only recorded in the interior, while in the frontal portion of the cave there are no Bronze Age remains.[15] Due to the impossibility and difficulty involved in following and distinguishing the layers which belong to the late Upper Palaeolithic from those belonging to the Mesolithic,[16] the layers were excavated arbitrarily at depths of 15-20 cm, and the depths were measured in relation to the existing walking surface in the cave.[17] Taking into consideration the inclination of the cave's floor,[18] and thereby also the sedimented layers, as well as the excavation methodology, a mixing of different geological and/or archaeological layers had to have occurred during the arbitrary digging of layers.[19] The excavated sediment was not sifted.

Based on radiocarbon dating, the cultural remains from Kopačina have been attributed to the Late Glacial period and early Holocene

13 Miracle 1995, str. 77, 80; Obelić et al. 1994, str. 304. Za kalibraciju datuma korišten je program OxCal 4.1.7 (Bronk-Ramsey 2009) i kalibracijska krivulja IntCal 09 (Reimer et al. 2009). Apsolutni datumi u Tablici 1. pod laboratorijskom oznakom Z-2403 i Z-2404 navedeni su prema Obelić et al. 1994, i nešto su stariji od datuma koje navodi Miracle 1995, str. 77 (Z-2403 12935 ± 250; Z-2404 11850 ± 220). Datumi koje navodi P. Miracle vjerojatno nisu korigirani za $\delta^{13}C$ (usmeno priopćenje B. Obelić, N. Horvatinčić, I. Krajcar-Bronić). Apsolutnim datumom (Z-776) dobivena je starost travertina nataloženog oko sloja s puževima, koji je kronološki okvirno paralelan s kasnim neolitikom - *kasni Hvar* (Forenbaher et al. 2010, str. 345), ali arheološki nalazi iz kasnog neolitika u pećini nisu pronađeni.
14 Miracle 1995; Miracle 1996.
15 Čečuk 1996, str. 16, 23. Detaljan opis stratigrafije na temelju svojih i Čečukovih terenskih zabilješki daje Miracle 1995, str. 76-78.
16 Čečuk 1981, str. 10; Čečuk 1989a, str. 30; Čečuk 1996, str. 18.
17 Napominjemo da među litičkim materijalom ima vrećica s oznakama dubine koje obuhvaćaju raspon od nekoliko desetaka centimetara.
18 Čečuk 1981, str. 10, bilj. 2.
19 Miracle je detaljno ukazao na ovaj problem; Miracle 1995, str. 71.

13 Miracle 1995, pp. 77, 80; Obelić et al. 1994, p. 304. The OxCal 4.1.7 program (Bronk-Ramsey 2009) and the IntCal 09 calibration curve (Reimer et al. 2009) were used to calibrate the dates. The absolute dates in Table 1 under laboratory designations Z-2403 and Z-2404 are cited according to Obelić et al. 1994 and they are somewhat older than the dates cited by Miracle 1995, p. 77 (Z-2403 12935±250; Z-2404 11850± 220). The dates cited by Miracle were probably not adjusted by $\delta^{13}C$ (personal communication from B. Obelić, N. Horvatinčić, I. Krajcar-Bronić). The absolute date (Z-776) was obtained by the age of the travertine deposited around the layer with snails, which is chronologically parallel to the Late Neolithic - *late Hvar* (Forenbaher et al. 2010, p. 345), but archaeological finds from the Late Neolithic were not found in the cave.
14 Miracle 1995; Miracle 1996.
15 Čečuk 1996, pp. 16, 23. A detailed description of the stratigraphy based on his and Čečuk's field notes is provided by Miracle 1995, pp. 76-78.
16 Čečuk 1981, p. 10; 1989a, p. 30; Čečuk 1996, p. 18.
17 It is worth noting that among the lithic materials there are bags bearing designations of the depths, which cover a range of several dozen centimetres.
18 Čečuk 1981, p. 10, note 2.
19 Miracle discussed this problem in detail; Miracle 1995, p. 71.

Na temelju apsolutne starosti i dubina čini se da najveći dio stratigrafskog slijeda iz Kopačine treba pripisati kasnom glacijalu. Apsolutnu radiokarbonsku starost od 9160 ± 100 BP (Z-778)[20] koja bi dio stratigrafskog slijeda iz Kopačine smjestila u rani holocen, treba uzeti s oprezom jer datumi dobiveni datiranjem kućica kopnenih puževa vrlo često odstupaju od stvarne vrijednosti.[21] U našem slučaju možemo pretpostaviti preveliku starost navedenog uzorka kućice kopnenog puža. Posebno velika odstupanja zabilježena su kod vrsta vezanih uz vapnenačku podlogu,[22] a veliki broj pronađenih *Helix* sp. u Kopačini definitivno je vezan uz vapnenačku kršku podlogu.

Based on the absolute age and depth, it would appear that the majority of the stratigraphic sequence from Kopačina should be ascribed to the Late Glacial period. The absolute radiocarbon age of 9160 ± 100 BP (Z-778),[20] which would place the part of the stratigraphic sequence from Kopačina in the early Holocene, should be taken with some reserve, for the dates obtained by dating shells of terrestrial snails quite often deviate from actual values.[21] In this case, it is possible to estimate an excessive age for the sample of snail shells. Considerable deviation was recorded among species tied to the limestone base,[22] while a high number of the *Helix sp.* discovered in Kopačina is definitely tied to the karst limestone base.

4. Metodologija

Litički skup nalaza iz Kopačine broji ukupno 13.763 kamena artefakta i teži 68.819,5 grama. Tehno-tipološki je obrađeno 12.494 artefakta, a preostali dio samo je prebrojan i izvagan (tablica 2).

U tehnološkom dijelu litičke analize definirano je ukupno 17 kategorija (gomolj ili oblutak, prvotni odbojak, prvotno sječivo, prvotna pločica, drugotni odbojak, drugotno sječivo, drugotna pločica, odbojak, sječivo, pločica, jezgra, ulomak jezgre, krijestasti komad, dotjerujući odbojak jezgre, odbojak dubila, krhotina i neodredivo) koje mogu predstavljati različite faze proizvodnog procesa. Prvotni odbojak, sječivo i pločica predstavljaju artefakte kojima je 80-100 % dorzalne strane prekriveno okorinom, dok drugotni odbojak, sječivo i pločica imaju manje od 80 % dorzalne strane prekrivene okorinom. Kriterij za razlikovanje sječiva i pločica je duljina (sječiva ≥ 3 cm). Među krhotine su svrstani svi komadi koji se ne mogu svrstati ni u jednu drugu kategoriju, a ne pokazuju smjer odbijanja. Jezgre su izdvojene kao zasebna tehnološka kategorija, ali ovdje nije napravljena njihova podrobnija analiza, jer je ona predmet daljnje obrade u doktorskoj disertaciji jednog od autora ovog rada (N. V.). Tipološka analiza najvećim je dijelom utemeljena na tipologiji za gornji paleolitik P.-Y. Demarsa i P. Laurenta,[23] pa su tako u skladu s njom definirani pojedini tipovi (noktolika grebala, zakrivljeni šiljci s hrptom, pločice s hrptom, gravetijenski šiljci, geometrijski mikroliti, strugala, iskrzani komadići, svrdla, dubila, zarupci, dok su pojedini tipovi kao npr. komadići sa sitnom rubnom obradom, kružno grebalo, grebalo na odbojku, grebalo na sječivu/pločici i mikrograveta dodani. Dubila su ovdje promatrana kao cjelina i nisu se izdvajali različiti tipovi. Iskrzani komadići ovdje su tretirani kao alatke, iako ih se u literaturi tretira i kao bipolarne jezgre.[24] U oba slučaja iskrzani komadići pokazuju korištenje bipolarne tehnologije odbijanja. U tehnološkom smislu iskrzani komadi su razvrstani kao odbojci ili kao jezgre reducirane do kraja. Obrada litičkog skupa nalaza prikupljenog tijekom višegodišnjih istraživanja donekle je ograničena samom metodologijom iskopavanja.

4. Methodology

The lithic assemblage from Kopačina contains a total of 13,763 stone artefacts, with a weight of 68,819.5 grams. 12,494 artefacts underwent techno-typological analysis, while the remaining portion was only counted and weighed (Table 2).

In the technological portion of the lithics analysis, a total of 17 categories were defined (nodule and cobble, primary flake, primary blade, primary bladelet, secondary flake, secondary blade, secondary bladelet, flake, blade, bladelet, core, core fragment, crested piece, core rejuvenation flake, burin spall, chunk and indeterminate), which may represent different phases of the production process. The primary flake, blade and bladelet are artefacts on which 80-100% of the dorsal side is covered with cortex, while the secondary flake, blade and bladelet have less than 80% of the dorsal side covered with cortex. The criteria for distinguishing between blades and bladelets is the length (blade ≥ 3 cm). Pieces were classified among the chunks which could not be placed in any other category, and which do not exhibit a flaking direction. Cores have been set aside as a separate technological category, but here they were not subjected to a more thorough-going analysis, for the latter will be covered in the doctoral dissertation of one of the authors of this paper (N.V.). The typological analysis was largely based on the typology of the Upper Palaeolithic by P.-Y. Demars and P. Laurent,[23] so in this regard, individual types have been defined (thumbnail endscrapers, curved backed points, backed bladelets, Gravettian points, geometric microliths, sidescrapers, splintered pieces, borers, burins, truncations), while individual types such as, for example, marginally retouched piece, circular endscraper, endscraper on flake, endscraper on blade/bladelet and micro-Gravette were added. Burins are here examined as a whole and they were not separated into different types. Splintered pieces are here treated as tools, even though they are also treated as bipolar cores in the literature.[24] In both cases, splintered pieces exhibit use of bipolar flaking technology. In the technological sense, splintered pieces were classified as flakes or as completely reduced cores. The analysis of the lithic assemblage gathered during the many years of research was limited by the actual excavation methodology.

	Broj	Težina (g)
s oznakom dubine	12494	61872,6
bez oznake dubine	844	4849,0
površinski nalazi	118	535,4
izdvojeno iz obrade	307	1562,5
ukupno	**13763**	**68819,5**

Tablica 2.
Litički skup nalaza iz Kopačine - broj i težina

	No.	Weight (g)
with designation of depth	12494	61872.6
without designation of depth	844	4849.0
surface finds	118	535.4
excluded from analysis	307	1562.5
total	**13763**	**68819.5**

Table 2.
Lithic assemblage from Kopačina - number and weight

Najveći dio litičkog skupa nalaza nosi oznake dubine u rasponu po 20 cm, počevši od 0 do 300 cm, a već je spomenuto da ima i vrećica s oznakama raspona dubina od nekoliko desetaka centimetara. Prema oznakama na vrećicama, najveća dubina na kojoj su zabilježeni kameni artefakti u unutrašnjosti pećine je 170 cm, a u prednjem dijelu pećine 300 cm.[25] Sve skupine kamenih artefakata s istim oznakama dubine razvrstane su te tehno-tipološki obrađene i međusobno uspoređene.[26] Tehnološka analiza pokazala je da od vrha stratigrafskog slijeda pa do dna postoji dosta ujednačena slika. Tipološka analiza pokazala je vjerojatnom mogućnost izdvajanja dvije litičke faze. Na temelju relativne učestalosti pločica s hrptom i zakrivljenih šiljaka s hrptom, koji su vrlo jasno tipološki odredivi, definirane su dvije litičke faze (dodatak 1). Mlađa faza (litička faza II) obuhvaćala bi dubine od 0-140, a starija (litička faza I) od 140-300 cm. U obje faze prisutna su oba tipa alatki, ali je relativna učestalost pločica s hrptom nekoliko puta veća u mlađoj fazi, dok je obrnuto u starijoj fazi. Ostale sličnosti i razlike bit će istaknute u poglavlju s usporedbom ove dvije faze. Nakon što su ovako definirane dvije litičke faze, ostatak materijala s različitim oznakama dubina (najčešće većim od 20 cm) pribrojen je jednoj ili drugoj fazi ovisno o dubini, a pritom se učestalost tipova nije značajnije promijenila.[27]

The majority of the lithic assemblage bears depth designations at increments of 20 cm, starting with 0 and going to 300 cm, while earlier it was noted that there are also bags with designations of depths to several dozen centimetres. According to the designations on the bags, the greatest depth at which stone artefacts were recorded in the cave's interior is 170 cm, and 300 cm in the front section of the cave.[25] All of the groups of stone artefacts with the same designations of depth have been grouped and techno-typologically analyzed and compared to one another.[26] The technological analysis has shown a rather uniform picture from the top of the stratigraphic sequence to its bottom. Typological analysis has shown that the possibility of distinguishing two lithic phases is likely. Based on the relative frequency of backed bladelets and curved backed points, which are very clearly typologically classifiable, two lithic phases have been defined (appendix 1). The younger phase (lithic phase II) would encompass depths of 0-140 cm, while the older phase (lithic phase I) depths of 140-300 cm. Both types of tools are present in both phases, but the relative frequency of backed bladelets is several times higher in the younger phase, while it is the reverse in the older phase. The remaining similarities and differences will be highlighted in the section on comparisons between these two phases. After the two lithic phases have been so defined, the remainder of the materials with differing depth designations (most often greater than 20 cm) was counted among one or the other phase depending on depth, and in this process the frequency of types did not change significantly.[27]

Petroarheološko ispitivanje litičkog inventara iz pećine Kopačine pokušaj je povezivanja kamenih artefakata s mogućim izdancima stijena korištenih za njihovu izradu.[28] Početna petrografska analiza artefakata obavljena je makroskopskim pregledom inventara s ciljem definiranja petrografskih, tj. materijalnih tipova. Mikrofacijalnom analizom uzoraka

Petroarchaeological examination of the lithic assemblage from Kopačina Cave constituted an attempt to link the stone artefacts with possible outcrops of rock used to make them.[28] The initial petrographic

20 Miracle 1995, str. 77.
21 Tamers 1970; Goodfriend 1987; Goodfriend, Stipp 1983; Goodfriend 1992.
22 Goodfriend, Stipp 1983, str. 576, T. 1.
23 Demars, Laurent 1992.
24 Whallon 1999.
25 Prema Čečuku 2006, str. 149, najveća dosegnuta dubina u prednjem dijelu pećine je 360 cm, a u stražnjem 270 cm.
26 U ovoj fazi napravljena je usporedba samo između skupina koje obuhvaćaju raspon od po 20 cm, počevši od 0 pa do 300 cm.
27 Vrećice sa sljedećim oznakama dubina pribrojene su litičkoj fazi I: 140-180, 145-180, 150-170, 150-180, 200-260 i 290-? (sve u cm), a litičkoj fazi II pribrojene su vrećice sa sljedećim oznakama dubina: 0-30, 0-50, 0-65, 0-80, 20-50, 30-60, 30-60, 30-70, 30-90, 60-120, 65-135, 80-110, 80-130, 90-110, 100-130, 100-140, 110-130 i 110-140 (sve u cm). Određeni broj artefakata (307) izdvojen je iz obrade jer bi prema oznakama dubina na vrećicama (110-150 i 120-150 cm) dijelom pripadali LF I, a dijelom LF II.
28 Geološki uzorci, datoteka makroskopskih i mikroskopskih nalaza kao i mikroskopske snimke su iz Geoarheološke litoteke, Perhoč 2010.

20 Miracle 1995, p. 77.
21 Tamers 1970; Goodfriend 1987; Goodfriend and Stipp 1983; Goodfriend 1992.
22 Goodfriend and Stipp 1983, p. 576, P. 1.
23 Demars, Laurent 1992.
24 Whallon 1999.
25 Based on Čečuk 2006, p. 149, greatest depth reached in the cave's front was 360 cm, and 270 cm in its rear.
26 In this phase, a comparison was made only between the groups encompassing a range of 20 cm, beginning with 0 and going to 300 cm.
27 The bags with the following depth designations were counted in lithic phase I: 140-180, 145-180, 150-170, 150-180, 200-260 and 290-? (all in cm), while the bags with the following designations were counted in lithic phase II: 0-30, 0-50, 0-65, 0-80, 20-50, 30-60, 30-60, 30-70, 30-90, 60-120, 65-135, 80-110, 80-130, 90-110, 100-130, 100-140, 110-130 and 110-140 (all in cm). A certain number of artefacts (307) were separated from analysis for based on the depth designations on the bags (110-150 and 120-150 cm) they would partially belong to LP I, and partially to LP II.
28 The geological samples, database on macro- and microscopic finds and microscopic images are from the Geoarchaeological Lithotheque, Perhoč 2010.

materijalnih tipova provjereno je makroskopsko petrografsko određenje, a karakterizacija tipova je dopunjena.[29] Udruživanje pojedinih tipova po srodnosti u skupine olakšalo je povezivanje s izdancima takvih stijena. Materijalne skupine artefakata nastojali smo dovesti u vezu s mogućim izvorima temeljem rezultata vlastitih terenskih istraživanja i ispitivanja petrografskih uzoraka, temeljem geoloških bibliografskih izvora te zahvaljujući obavijestima kolega geologa i arheologa o izvorima predmetnih stijena.

Analizom je obuhvaćen inventar iskopan u nekoliko kampanja poduzetih između 1978. i 1993. godine iz slojeva do 3,00 m dubine. Makroskopski i povećalom s povećanjem od 10 i 20 puta pregledano je 4600 nalaza, ukupne težine 22.366,39 grama, pri čemu su izdvojeni klasifikacijski uzorci petrografskih tipova po kojima je inventar sortiran. Petrografski tipovi izdvojeni su prema makroskopski utvrdivim značajkama: strukturi, boji, zrnatosti, transparentnosti, sjaju, pojavnom obliku stijene, tipu loma, oblicima trošnosti, tvrdoći i fosilifernosti. Istodobno je prema okorini[30] određen genetski tip rožnjaka[31]

analysis of artefacts was conducted by macroscopic inspection of the inventory with the objective of defining the petrographic, or rather material types. Microfacial analysis of the samples of material types verified the macroscopic petrographic classification, and the characterization of types was supplemented.[29] The linkage of individual types into groups based on similarity eased their ties to outcrops of such rock. We attempted to draw a connection between material groups of artefacts and potential sources based on the results of our own field research and testing of petrographic samples, geological bibliographic sources and thanks to reports from our fellow geologists and archaeologists on the sources of these stones.

The analysis encompassed the inventory excavated in several campaigns undertaken between 1978 and 1993 from layers up to 3 m deep. 4,600 finds, with a total weight of 22,366.39 g, were examined macroscopically and under a magnifying scope with 10 and 20 factor enlargement, wherein the classification samples of petrographic types by which the inventory was sorted were set apart. Petrographic types were distinguished according to macroscopically ascertained features: structure, colour, grain, transparency, lustre, outer appearance, fraction type, forms of wear, density and fossiliferous quality. Simultaneously, based on cortex,[30]

29 Makroskopsku i mikroskopsku analizu nismo bili u prilici izvoditi sinkrono, već sukcesivno.

30 Nodularna okorina (engl. *nodular rim*, *cortex*, *crust*; njem. *Knollenrinde*, *Kreiderinde*) je genetska kora nodularnog rožnjaka. To je periferni sloj nodule koji čini prijelaznu zonu prema stijeni domaćinu. Od jezgre nodule, tj. petrografski zrelog dijela rožnjaka, razlikuje se po mineralnom sastavu, boji, strukturi, tvrdoći, time i po stupnju rezistentnosti na trošenje. Mineraloški je to uglavnom kvarc, dok su relikti stijene domaćina (karbonatni minerali, struktura, fosili) česti. Izraz "nodula", hrv. gomolj (Tišljar 2004, str. 221), engl. *nodule* (Pettijohn 1957, str. 200), njem. *Hornstein-Knolle* (Füchtbauer, Müller 1970, str. 494), u geologiji označava tip kemijske sekundarne strukture sedimentne stijene. Nodule nastaju precipitiranjem kvarca iz vodene otopine silicijske kiseline oko neke jezgre, često organske tvari, fragmenta školjke ili fosila. Nodule su zaobljenih ploha i sferičnih, diskoidnih ili potpuno nepravilnih oblika. Javljaju se pojedinačno i u skupinama usporedo sa slojevima stijene domaćina ili vrlo razvedenih oblika spojenih u proslojke. Mogu biti milimetarskog do metarskog reda veličine. Valutična okorina (njem. *Geröllrinde*; engl. *rind of pabbles*) je tip kore trošenja (engl. *weathering rind*, njem. *Verwitterungsrinde*) specifičan za šljunak. To je vanjski sloj valutice (oblutka) bilo koje vrste stijene, na kojoj u sedimentacijskom ciklusu (naročito trošenjem tijekom transporta) dolazi do fizikalnih (pohabanost, zaobljenost, napukline) i mineralnih promjena (patina), što rezultira promjenama u strukturi i boji. Izraz "fluvijalni korteks" trebalo bi koristiti samo kad je tip transporta poznat. *Valutična nodularna okorina* nastaje habanjem nodule rožnjaka u vodenom transportu zbog čega je genetska okorina reducirana, ali barem mjestimice prepoznatljiva kao takva dok je noduli djelomično izmijenjen oblik. *Valutična nodularna okorina* na artefaktu arheologu omogućuje očitavanje podataka o varijetetu rožnjaka i tipu izdanka na kojem je nabavljena sirovina za litičku proizvodnju. U brojnim slučajevima je geoarheolozima upravo korteks artefakata, osim boje i makrostrukture, indikativan čimbenik u prepoznavanju regionalnih tipova rožnjaka i njihovih izdanaka (npr. regionalni tip nodularne okorine u kontekstu *"Maas"-Knollenflinta* i valutična okorina označena je kao *"Maas"-Rinde*; usp. Arora 1979, str. 2-5).

31 Genetski tipovi silicijskih sedimentnih stijena, odnosno rožnjaka *sensu lato* su biogeni, dijagenetski, kemogeni i alteracijski (Tišljar 2004, str. 209).

29 Macroscopic and microscopic analysis could not be conducted simultaneously, but rather successively.

30 Nodular rim (also nodular cortex, crust; Cro. *nodularna okorina*; Germ. *Knollenrinde*, *Kreiderinde*) is the genetic crust of nodular chert. This is the peripheral layer of the nodule which forms the transition zone toward the host rock. It differs from the nodule's core, i.e., the petrographically mature part of the chert, in terms of mineral composition, colour, structure, density, and thereby also resistance to wear. Mineralogically this is generally quartz, while relics of the host rock (carbonate minerals, structure, fossils) are frequent. In geology, the term "nodule" (Pettijohn 1957, p. 200), Cro. *gomolj* (Tišljar 2004, p. 221), Germ. *Hornstein-Knolle* (Fürchtbauer, Müller 1970, p. 494) designates a type of chemically secondary structure of sedimentary rock. Nodules form by precipitation of quartz from silicic acid aqueous solutions around a core, often organic substances, shell fragments or fossils. Nodules have rounded surfaces and spherical, discoid or entirely irregular shapes. They appear individually and in groups parallel to layers of host rock or in very irregular shapes connected in interlayers. Their size can be measured from millimetres to meters. A rind of pebbles (Cro. *valutična okorina*; Germ. *Geröllrinde*) is a type of weathering rind (Cro. *kora trošenja*; Germ. *Verwitterungsrinde*) specific to gravel. This is an external layer of pebbles (cobbles) of any type of rock, which - during the sedimentation cycle (particularly wear during conveyance) - undergoes physical (polish, rounding, fissures) and mineral changes (patina), which results in changes in both structure and colour. The expression "fluvial cortex" should be used only when the conveyance type is not known. The *nodular rind of pebbles* is created by weathering of the chert nodule during conveyance by water, which results in reduction of the genetic rind, or what is at a minimum recognized as such, while the nodule's shape is partially altered. The *nodular rind of pebbles* on an artefact enables an archaeologist to decipher data on the variety of chert and the type of outcrop in which the raw material for lithic production was obtained. In numerous cases, an artefact's cortex, in addition to colour and macrostructure, actually serves geoarchaeologists as an indicative factor in the recognition of regional types of cherts and their outcrops (e.g. regional type of nodular cortex in the context of *"Maas"-Knollenflint* and a rind of pebbles designated as *"Maas"-Rinde*; cf. Arora 1979, pp. 2-5).

i pripadnost tipu pretpostavljenog izdanka.[32] Makroskopsko uzorkovanje petrografskih tipova kontrolirano je pregledom više od 120 nabrušenih preparata binokularnim mikroskopom s povećanjem od 25 i 100 puta. Karbonatna komponenta je u pojedinih nalaza ispitana razrijeđenom solnom kiselinom. Petrografsko određenje radiolarita i metasomatskog rožnjaka[33] dodatno je potvrđeno polarizacijskim, odnosno rasterelektronskim mikroskopom.[34] Pri određivanju boje prema standardima Rock-Color-Chart, površine kamenih nalaza su navlažene.[35]

Temeljem navedenih kriterija, izdvojene su sljedeće osnovne materijalne skupine arheoloških nalaza: radiolariti, metasomatski rožnjaci i skupina petrografski neodređenih rožnjaka.[36]

5. Tehno-tipološka analiza
5.1. Litička faza I - tehnologija

U litičkoj fazi I (dalje u tekstu LF I) zabilježeno je 4928 kamenih artefakata ukupne težine 20.572,4 grama. Od ukupnog broja alatke čine oko 14 % (689 komada). U ovoj fazi odbojci predstavljaju prevladavajuću proizvodnu kategoriju s relativnom učestalošću od 47,75 %. Zajedno s okorinskim odbojcima (prvotni 2,56 % i drugotni 14,14 %) ukupna relativna učestalost odbojaka je 64,45 %. Nakon odbojaka sljedeća najzastupljenija tehnološka kategorija su krhotine s učestalošću od 18,75 %, a slijede jezgre sa 9,26 %. Učestalost ostalih tehnoloških kategorija je ispod 5 % (tablica 3). Nasuprot odbojcima kojih je u ukupnom broju litike jako puno, i koji predstavljaju apsolutno preferirajući proizvod lomljenja, sječiva su prisutna u malom broju, s učestalošću od 5,23 % (bez okorine 4,20 %, s okorinom 1,03 %), a učestalost pločica je i puno manja te iznosi 1,9 % (bez okorine 1,7 %, s okorinom 0,2 %). Mali broj pločica mogao bi biti posljedica neprosijavanja sedimenta.

Međutim, iako je relativna učestalost sječiva i pločica u ukupnoj količini litike mala, veliki broj ih je formalno obrađen (sl. 1). Od ukupnog broja odbojaka obrađeno je 15,64 %, dok je

32 Izdanak stijene je mjesto na kojem je ona dostupna na svom ležištu. Autohtoni ili paraautohtoni izdanak rožnjaka je mjesto njegova postanka u stijeni domaćinu i dostupnosti ili mjesto erozije u neposrednoj blizini. Alohtoni izdanak rožnjaka je mjesto manje-više udaljeno od njegova postanka na kojem je nataložen nakon što je erodiran iz stijene domaćina i tijekom transporta manje-više preoblikovan. Neki autori autohtoni izdanak nazivaju primarnim, a alohtoni sekundarnim. Tragovi procesa trošenja (valutična okorina) i strukturalne značajke stijene (nodularna okorina) vidljivi na artefaktima, ukazuju na tip izdanka s kojeg potječe kamen.

33 Određenje fosila obavljeno je prema Flügel 1978. i Adams et al. 1984.

34 Mikroskopiranje nalaza omogućeno nam je zahvaljujući prof. dr. sc. Raineru Altherru, Institut für Geowissenschaften, Rupprecht-Karls-Universität Heidelberg, i prof. dr. sc. Ernstu Pernicki, Curt-Engelhorn-Zentrum Archäometrie Mannheim.

35 The Geological Society of Amerika, 1995.

36 Nazivi svih materijalnih skupina arheoloških nalaza imaju radni karakter.

the genetic chert type[31] and classification to the assumed outcrop type[32] were determined. Macroscopic sampling of petrographic types was controlled by an inspection of over 120 polished sections under a binocular microscope with enlargement factor of 25 of 100. The carbonate component was tested in individual samples with diluted hydrochloric acid. The petrographic determination of radiolarites and metasomatic cherts[33] was additionally confirmed under a polarized light and scanning light microscope.[34] In determining the colour according to the standards of the Rock-Colour-Chart, the surface of the stone surfaces were moistened.[35]

Based on the above criteria, the following basic material groups for the archaeological finds were distinguished: radiolarites, metasomatic cherts and petrographically indeterminate chert group.[36]

5. Techno-typological analysis
5.1. Lithic phase I - technology

In lithic phase I (hereinafter LP I), 4,928 stone artefacts were recorded with a total weight of 20,572.4 g. Out of the total number, tools account for approximately 14% (689 pieces). In this phase, flakes constitute the predominant production category with relative frequency of 47.75%. Together with decortication flakes (primary, 2.56% and secondary, 14.14%), the total relative frequency of flakes is 64.45%. After flakes, the next most common technological category encompasses chunks, with a frequency of 18.75%, followed by cores with 9.26%. The frequency of the remaining technological categories is below 5% (Table 3). In contrast to flakes, of which there is a considerable amount in the total number of lithics and which constitute the absolutely preferred product of knapping, blades are present in a small number with a frequency of 5.23% (without cortex, 4.20%, with cortex, 1.03%), while the frequency of bladelets is much lower, at 1.9% (without cortex, 1.7%, with cortex, 0.2%). The small number of bladelets may be the result of the failure to sift the sediments.

However, although the relative frequency of blades and bladelets in the total quantity of lithics is small, a high number of them has been

31 Genetic types of silicate sedimentary rock, or *sensu lato* cherts are biogenetic, diagenetic, chemogenetic and alterative (Tišljar 2004, p. 209).

32 The outcrop of a rock is the place at which it is accessible in its deposit. An autochthonous or para-autochthonous outcrop of chert is its point of origin in the host rock and its point of accessibility, or in the immediate vicinity. An allochthonous outcrop of chert is a place more or less remote from its point of origin, at which it was deposited after its erosion from the host rock and more or less transformed during conveyance. Some scholars called the autochthonous outcrop primary, and the allochthonous secondary. Traces of the wear process (rind of pebbles) and structural features of the rock (nodular rim) visible on artefacts indicate the type of outcrop from which the stone originated.

33 Specification of the fossils was done according to Flügel 1978 and Adams et al. 1984.

34 Microscope analysis of the finds was made possible thanks to Professor Rainer Altherr, Institut für Geowissenschaften, Rupprecht-Karls-Universität Heidelberg and Professor Ernst Pernicka, Curt-Engelhorn-Zentrum Archäometrie Mannheim.

35 The Geological Society of America, 1995.

36 The names of all material groups of archaeological finds are still provisional in character.

	neobrađeno				obrađeno			
	kom.	%	g	%	kom.	%	g	%
gomolj	0	0,00	0,0	0,00	0	0,00	0,0	0,00
prvotni odbojak	77	1,56	391,1	1,90	5	0,10	27,4	0,13
prvotno sječivo	1	0,02	2,5	0,01	0	0,00	0,0	0,00
prvotna pločica	0	0,00	0,0	0,00	0	0,00	0,0	0,00
drugotni odbojak	588	11,93	2066,7	10,05	109	2,21	496,2	2,41
drugotno sječivo	16	0,32	43,5	0,21	34	0,69	127,7	0,62
drugotna pločica	9	0,18	8,5	0,04	1	0,02	0,9	0,00
odbojak	1977	40,12	4905,7	23,85	376	7,63	1373,5	6,68
sječivo	113	2,29	291,6	1,42	94	1,91	310,2	1,51
pločica	50	1,01	43,1	0,21	34	0,69	29,4	0,14
jezgra	430	8,73	4783,4	23,25	26	0,53	137,6	0,67
ulomak jezgre	22	0,45	122,8	0,60	0	0,00	0,0	0,00
krijetasti komad	5	0,10	13,3	0,06	0	0,00	0,0	0,00
dotjerujući odbojak jezgre	23	0,47	94,4	0,46	5	0,10	32,5	0,16
odbojak dubila	5	0,10	9,4	0,05	0	0,00	0,0	0,00
krhotina	923	18,73	5238,2	25,46	1	0,02	15,9	0,08
neodredivo	0	0,00	0,0	0,00	4	0,08	6,9	0,03
ukupno	**4239**	**86,02**	**18014,2**	**87,56**	**689**	**13,98**	**2558,2**	**12,44**

	unretouched				retouched			
	pcs.	%	g	%	pcs.	%	g	%
nodule	0	0.00	0.0	0.00	0	0.00	0.0	0.00
primary flake	77	1.56	391.1	1.90	5	0.10	27.4	0.13
primary blade	1	0.02	2.5	0.01	0	0.00	0.0	0.00
primary bladelet	0	0.00	0.0	0.00	0	0.00	0.0	0.00
secondary flake	588	11.93	2066.7	10.05	109	2.21	496.2	2.41
secondary blade	16	0.32	43.5	0.21	34	0.69	127.7	0.62
secondary bladelet	9	0.18	8.5	0.04	1	0.02	0.9	0.00
flake	1977	40.12	4905.7	23.85	376	7.63	1373.5	6.68
blade	113	2.29	291.6	1.42	94	1.91	310.2	1.51
bladelet	50	1.01	43.1	0.21	34	0.69	29.4	0.14
core	430	8.73	4783.4	23.25	26	0.53	137.6	0.67
core fragment	22	0.45	122.8	0.60	0	0.00	0.0	0.00
crested piece	5	0.10	13.3	0.06	0	0.00	0.0	0.00
core rejuvenation flake	23	0.47	94.4	0.46	5	0.10	32.5	0.16
burin spall	5	0.10	9.4	0.05	0	0.00	0.0	0.00
chunk	923	18.73	5238.2	25.46	1	0.02	15.9	0.08
indeterminate	0	0.00	0.0	0.00	4	0.08	6.9	0.03
total	**4239**	**86.02**	**18014.2**	**87.56**	**689**	**13.98**	**2558.2**	**12.44**

Tablica 3.
Litička faza I - tehnologija

Table 3.
Lithic phase I - technology

obrađenih sječiva 49,61 %, a pločica 37,23 %. Kao i u sljedećoj fazi, i ovdje je iskoristivost sječiva i pločica izuzetno velika.

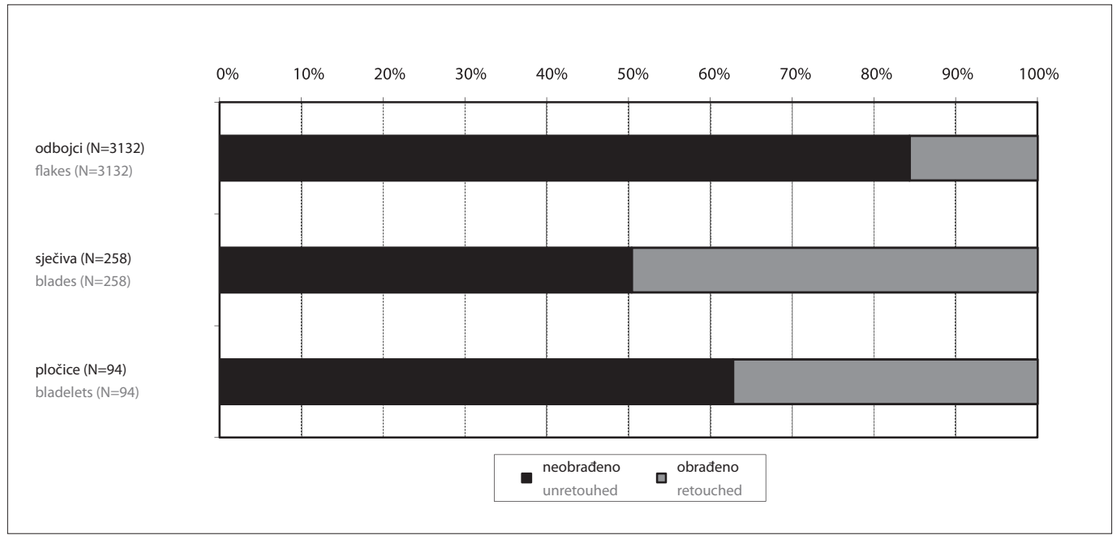
Najveći broja alatki izrađen je na odbojcima, slijede sječiva, zatim pločice, jezgre, dotjerujući odbojci jezgre i na kraju krhotine (tablica 3).

Gotovo sve faze lanca operacija su prisutne. Nedostaje samo inicijalna faza pribavljanja sirovine i mali odbojci (< 1 cm) koji bi ukazivali na finalnu izradu i dotjerivanje alatki na samom nalazištu, ali s obzirom na to da sediment nije prosijavan i da su prisutne gotovo sve ostale faze, možemo pretpostaviti da je nedostatak malih odbojaka jednostavno posljedica metodologije iskopavanja i da su alatke izrađivane u samoj pećini. Kao što je već spomenuto, slika je mogla biti nešto drugačija da se lanac operacija promatrao zasebno kroz pojedine sirovinske kategorije.

formally retouched (Fig. 1). Out of the total number of flakes, 15.64% has been retouched, while 49.61% of blades and 37.23% of bladelets have been retouched. As in the subsequent phase, here as well the usability of blades and bladelets is exceptionally high.

The highest number of tools was made on flakes, followed by blades, then bladelets, cores, core rejuvenation flakes and, in the end, chunks (Table 3).

Almost all phases of the operational sequence are present. Only missing is the initial phase of obtaining raw materials and small flakes (< 1 cm) which would indicate final production and refining tools at the site, but given that the sediment was not sifted and that almost all remaining phases are present, we may assume that the absence of small flakes is simply the result of the excavation methodology and that the tools were made in the cave itself. As already mentioned, the picture may have been somewhat different if the operational chain had been observed separately through individual raw material categories.



Slika 1.
Relativni odnos obrađenih i neobrađenih odbojaka, sječiva i pločica u LF I

Figure 1.
Relative frequency ratio between retouched and unretouched flakes, blades and bladelets in LP I

litička faza I (▼140 - 300 cm)		
Tip alatke	**kom.**	**%**
noktoliko grebalo	84	12,19
kružno grebalo	8	1,16
grebalo na odbojku	81	11,76
grebalo na sječivu/pločici	9	1,31
pločica s hrptom	6	0,87
zakrivljeni šiljak s hrptom	26	3,77
gravetijenski šiljak	2	0,29
kružni segment	1	0,15
zarubak	10	1,45
strugalo	82	11,90
svrdlo	15	2,18
dubilo	24	3,48
iskrzani komadić	58	8,42
komadić sa sitnom rubnom obradom	20	2,90
komadić s obradom	140	20,32
nazubak	94	13,64
udubak	18	2,61
ulomak s obradom	11	1,60
ukupno	**689**	**100,00**

litic phase I (▼140 - 300 cm)		
Tool type	**pcs.**	**%**
thumbnail endscraper	84	12.19
circular endscraper	8	1.16
endscaper on flake	81	11.76
endscraper on blade/bladelet	9	1.31
backed bladelet	6	0.87
curved backed point	26	3.77
Gravettian point	2	0.29
segment	1	0.15
truncation	10	1.45
sidescraper	82	11.90
borer	15	2.18
burin	24	3.48
splintered piece	58	8.42
marginally retouched piece	20	2.90
retouched piece	140	20.32
denticulate	94	13.64
notch	18	2.61
retouched fragment	11	1.60
total	**689**	**100.00**

Tablica 4.
Litička faza I - tipologija

Table 4.
Lithic phase I - typology

5.2. Litička faza I - tipologija (sl. 2 i 3)

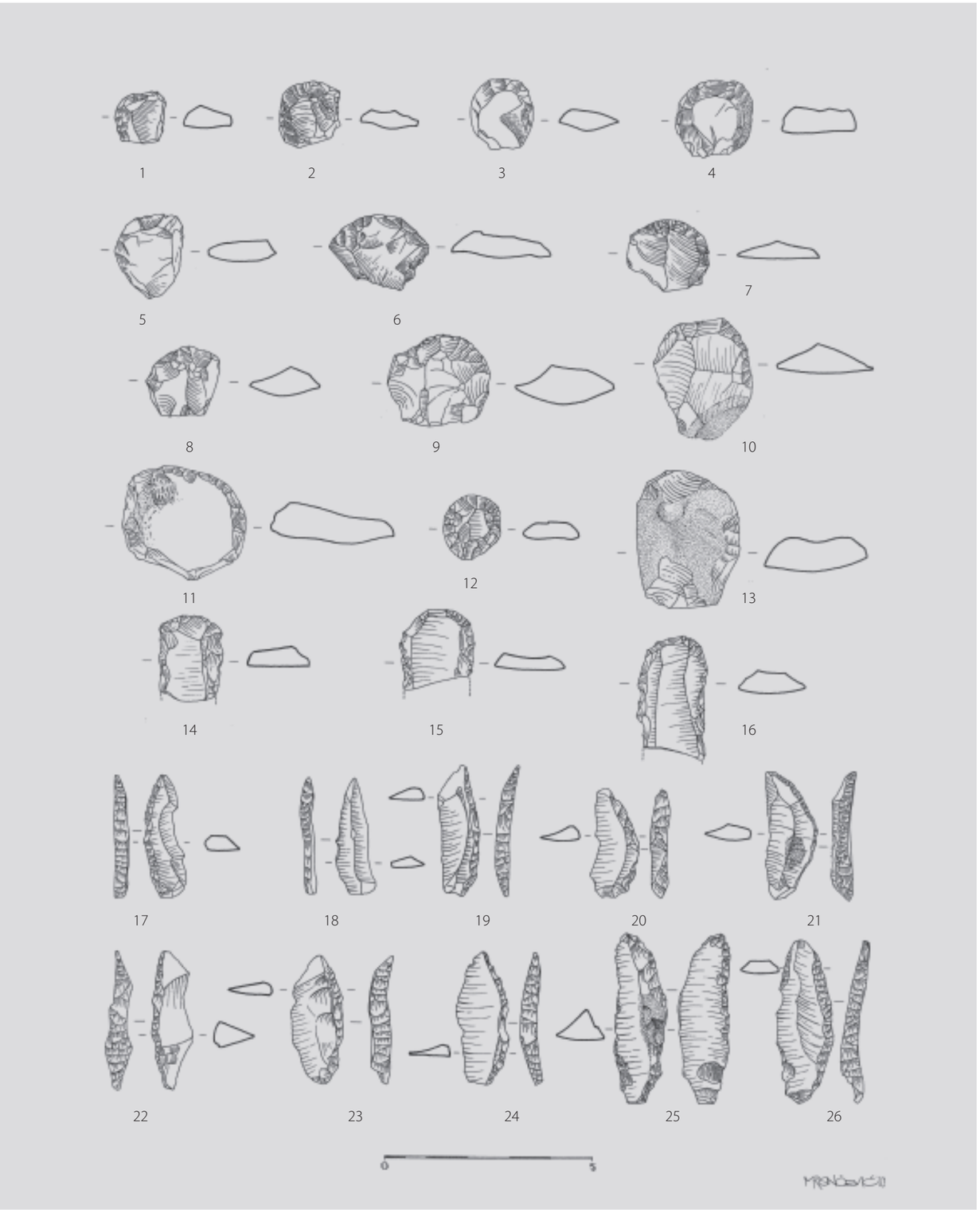
Ukupno 17 tipova alatki definirano je u LF I. Grebala čine najbrojniju skupinu, s učestalošću od 26,42 %. Među njima najbrojnija su noktolika grebala, slijede grebala na odbojku, zatim na sječivu/pločici i na kraju kružna (tablica 4).

Već smo u poglavlju o metodologiji spomenuli da je jedan od glavnih kriterija za izdvajanje ove faze kao zasebne cjeline bio odnos relativne učestalosti pločica s hrptom i zakrivljenih šiljaka s hrptom. Učestalost pločica s hrptom (sve su unilateralno strmo obrađene) u ovoj fazi iznosi 0,87

5.2. Lithic phase I - typology (Fig. 2 and 3)

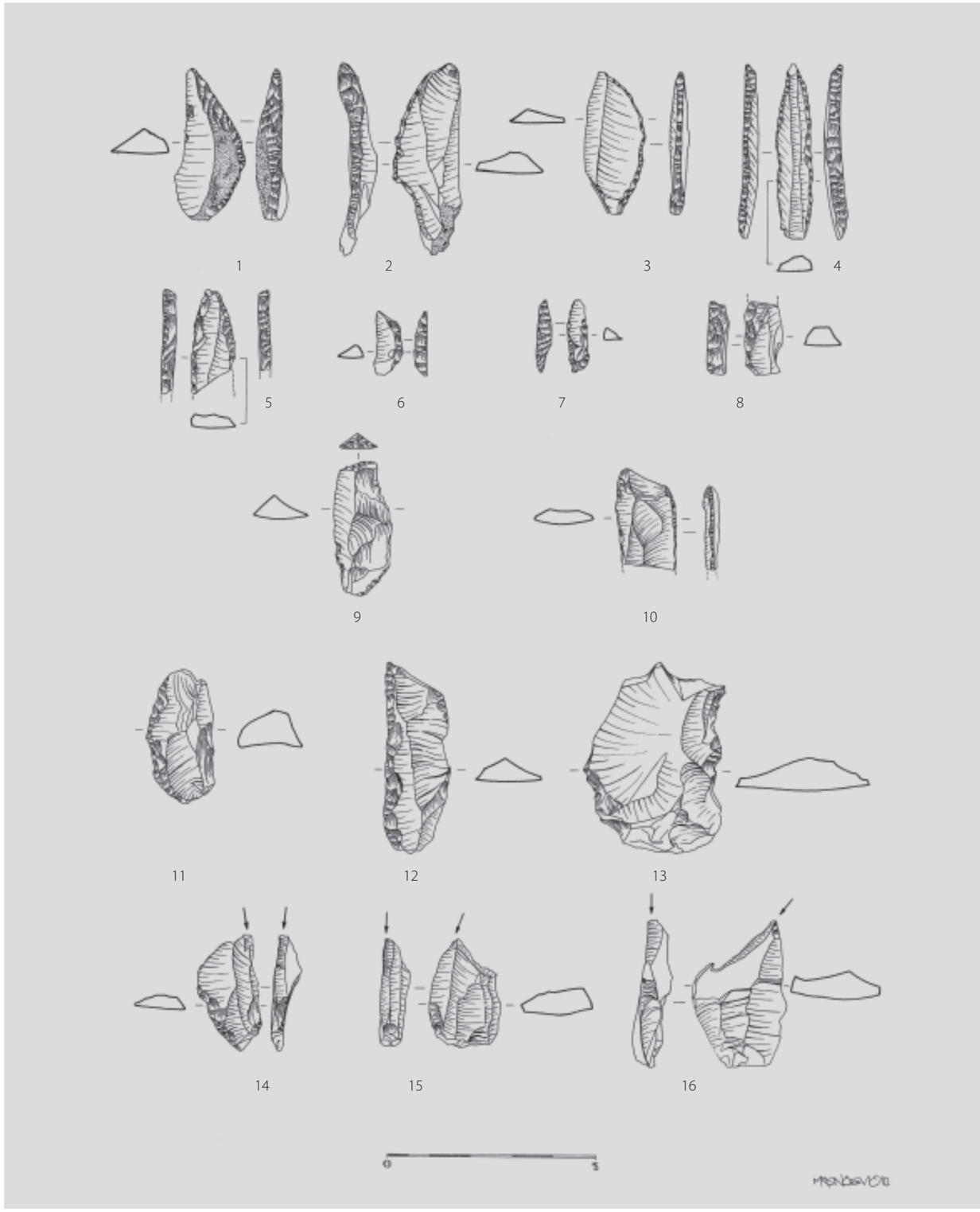
A total of 17 types of tools has been defined in LP I. Endscrapers account for the most numerous group of tools with a frequency of 26.42%. Among them, the most numerous are thumbnail endscrapers, followed by endscrapers on flakes, and then endscrapers on blades/bladelets, and finally circular endscrapers (Table 4).

In the section on methodology, we have already mentioned that one of the principal criteria for distinguishing these phases as separate units was the ratio between the relative frequency of backed bladelets and curved backed points. The frequency of



Slika 2.
Izbor kamenih alatki iz litičke faze I. 1-11: noktolika grebala, 12: kružno grebalo, 13: grebalo na odbojku, 14-16: grebala na sječivu/pločici, 17-26: zakrivljeni šiljci s hrptom

Figure 2.
Selection of stone tools from lithic phase I. 1-11: thumbnail endscrapers, 12: circular endscraper, 13: endscraper on flake, 14-16: endscrapers on blade/bladelet, 17-26: curved backed points



Slika 3.
Izbor kamenih alatki iz litičke faze I. 1-3: zakrivljeni šiljci s hrptom, 4, 5: gravetijenski šiljci, 6: kružni segment, 7, 8: pločice s hrptom, 9: zarubak, 10: komadić sa sitnom rubnom obradom, 11: strugalo, 12: svrdlo, 13: nazubak, 14-16: dubila

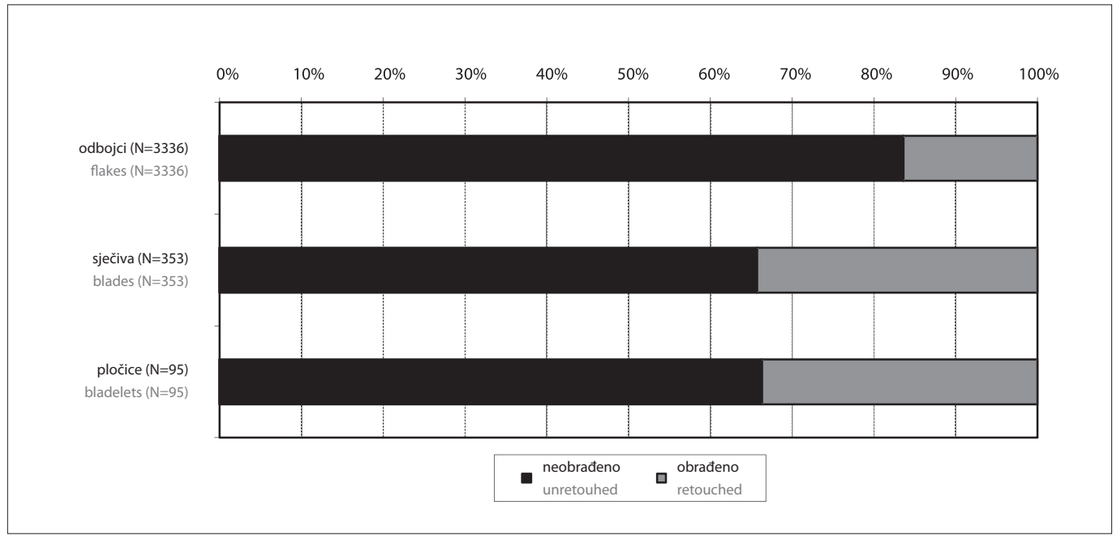
Figure 3.
Selection of stone tools from lithic phase I. 1-3: curved backed points, 4, 5: Gravettian points, 6: segment, 7, 8: backed bladelets, 9: truncation, 10: marginally retouched piece, 11: sidescraper, 12: drill, 13: denticulate, 14-16: burins

	neobrađeno				obrađeno			
	kom.	%	g	%	kom.	%	g	%
gomolj	1	0,01	95,8	0,23	0	0,00	0,0	0,00
prvotni odbojak	110	1,45	375,4	0,91	8	0,11	63,2	0,15
prvotno sječivo	2	0,03	6,6	0,02	1	0,01	11,3	0,03
prvotna pločica	0	0,00	0,0	0,00	0	0,00	0,0	0,00
drugotni odbojak	736	9,73	3310,7	8,02	128	1,69	598,5	1,45
drugotno sječivo	36	0,48	75,9	0,18	33	0,44	128,8	0,31
drugotna pločica	7	0,09	6,0	0,01	3	0,04	3,6	0,01
odbojak	2789	36,86	8543,4	20,69	547	7,23	2294,0	5,55
sječivo	232	3,07	538,9	1,30	121	1,60	458,5	1,11
pločica	63	0,83	54,3	0,13	32	0,42	24,9	0,06
jezgra	877	11,59	11100,9	26,88	31	0,41	169,3	0,41
ulomak jezgre	68	0,90	286,7	0,69	0	0,00	0,0	0,00
krijetasti komad	8	0,11	39,6	0,10	0	0,00	0,0	0,00
dotjerujući odbojak jezgre	37	0,49	176,2	0,43	4	0,05	24,7	0,06
odbojak dubila	11	0,15	21,4	0,05	0	0,00	0,0	0,00
krhotina	1666	22,02	12749,4	30,87	11	0,15	138,9	0,34
neodredivo	0	0,00	0,0	0,00	4	0,05	3,3	0,01
ukupno	**6643**	**87,80**	**37381,2**	**90,51**	**923**	**12,20**	**3919,0**	**9,49**

	unretouched				retouched			
	pcs.	%	g	%	pcs.	%	g	%
nodule	1	0.01	95.8	0.23	0	0.00	0.0	0.00
primary flake	110	1.45	375.4	0.91	8	0.11	63.2	0.15
primary blade	2	0.03	6.6	0.02	1	0.01	11.3	0.03
primary bladelet	0	0.00	0.0	0.00	0	0.00	0.0	0.00
secondary flake	736	9.73	3310.7	8.02	128	1.69	598.5	1.45
secondary blade	36	0.48	75.9	0.18	33	0.44	128.8	0.31
secondary bladelet	7	0.09	6.0	0.01	3	0.04	3.6	0.01
flake	2789	36.86	8543.4	20.69	547	7.23	2294.0	5.55
blade	232	3.07	538.9	1.30	121	1.60	458.5	1.11
bladelet	63	0.83	54.3	0.13	32	0.42	24.9	0.06
core	877	11.59	11100.9	26.88	31	0.41	169.3	0.41
core fragment	68	0.90	286.7	0.69	0	0.00	0.0	0.00
crested piece	8	0.11	39.6	0.10	0	0.00	0.0	0.00
core rejuvenation flake	37	0.49	176.2	0.43	4	0.05	24.7	0.06
burin spall	11	0.15	21.4	0.05	0	0.00	0.0	0.00
chunk	1666	22.02	12749.4	30.87	11	0.15	138.9	0.34
indeterminate	0	0.00	0.0	0.00	4	0.05	3.3	0.01
total	**6643**	**87.80**	**37381.2**	**90.51**	**923**	**12.20**	**3919.0**	**9.49**

Tablica 5.
Litička faza II - tehnologija

Table 5.
Lithic phase II - technology



Slika 4.
Relativni odnos obrađenih i neobrađenih odbojaka, sječiva i pločica u litičkoj fazi II

Figure 4.
Relative frequency ratio between retouched and unretouched flakes, blades and bladelets in lithic phase II

%, dok je učestalost zakrivljenih šiljaka s hrptom znatno veća i iznosi 3,77 %. U litičkom skupu nalaza faze I zabilježena su dva gravetijenska šiljka (0,29 %) koja su karakteristična za ovu fazu i ne javljaju se u onoj kasnijoj. Od geometrijskih mikrolita zastupljen je samo jedan primjerak kružnog segmenta. Najzastupljeniji pojedinačni tip alatke je komad s obradom relativne učestalosti od 20,32 %. Brojni su i nazupci (13,64 %), strugala (11,90 %) te iskrzani komadići (8,42 %).

5.3. Litička faza II - tehnologija

Litičku fazu II (dalje u tekstu LF II) čini ukupno 7566 kamenih artefakata težine 41.300,2 grama. Alatke čine oko 12 % (923 komada) litičkog skupa nalaza ove faze. Među tehnološkim kategorijama dominiraju odbojci s relativnom učestalošću od 44,09 %, a kad im se pridodaju prvotni (1,45 %) i drugotni odbojci (11,42 %), onda učestalost odbojaka raste na visokih 56,96 %. Slijede krhotine sa 22,17 %, zatim jezgre sa 12%, dok ostale kategorije imaju učestalost manju od 5 % (tablica 5). I u ovoj fazi, kao i u prethodnoj, udio sječiva koji iznosi 5,63 % (bez okorine 4,6 7%, s okorinom 0,96 %) i pločica 1,39 % (bez okorine 1,26 %, s okorinom 0,13 %), višestruko je manji od udjela odbojaka.

Unatoč malom broju sječiva i pločica u ukupnoj količini litike, veliki broj sječiva i pločica je formalno obrađen (sl. 4). Dok je kod odbojaka od ukupnog broja obrađeno 16,40 %, kod sječiva je 34,28 %, a kod pločica 33,68 %. To ukazuje na veliku iskoristivost sječiva i pločica. Sječiva i pločice više se dodatno obrađuju možda zbog toga što je tehnološki postupak njihova dobivanja složeniji od onog za dobivanje odbojaka.

Najveći broj alatki izrađen je na odbojcima, slijede sječiva, zatim pločice, jezgre, krhotine i dotjerujući odbojci jezgre (tablica 5).

U LF II, promatrano u cjelini, zabilježen je gotovo cjelokupni lanac operacija, od pribavljanja sirovine do odbacivanja alatki.[37] Slika lanca operacija mogla je biti nešto drugačija, da su se različite skupine sirovine promatrale zasebno. U tom slučaju možda ne bi bile prisutne sve faze u pojedinim kategorijama sirovine, osobito ako se uzme u obzir (potencijalna) relativno velika udaljenost (mogućih) pretpostavljenih izvora sirovine, ali to je predmet budućih istraživanja.

backed bladelets (all unilaterally backed) in this phase is 0.87%, while the frequency of curved backed points is considerably higher, at 3.77%. In the lithic assemblage in phase I, two Gravettian points (0.29%) were recorded, which are characteristic of this phase and do not appear in the later phase. Among the geometric microliths, only one example of a segment is present. The most common individual type of tool is retouched piece, with relative frequency of 20.32%. Denticulates (13.64%), sidescrapers (11.90%) and splintered pieces (8.42%) are also frequent.

5.3. Lithic phase II - technology

Lithic phase II (hereinafter LP II) consists of a total of 7,566 stone artefacts weighing 41,300.2 grams. The tools account for roughly 12% (923 pieces) of the lithic assemblage for this phase. Among the technological categories, flakes dominate with a relative frequency of 44.09%, and when primary (1.45%) and secondary flakes (11.42%) are added to them, then the frequency of flakes grows to a high 56.96%. These are followed by chunks with 22.17% and cores with 12%, while the remaining categories have a frequency less than 5% (Table 5). In this phase, as in the preceding one, the share of blades at 5.63% (without cortex, 4.67%, with cortex, 0.96%) and bladelets at 1.39% (without cortex, 1.26%, with cortex, 0.13%) is many times less than the share of flakes.

Despite the small number of blades and bladelets in the overall quantity of lithics, a high number of blades and bladelets was formally retouched (Fig. 4). While only 16.4% of the total number of flakes have been retouched, in the case of blades 34.28% were retouched, together with 33.68% of the bladelets. This indicates the high usability of blades and bladelets. Blades and bladelets underwent more additional retouching perhaps because the technological procedure to produce them was more complex than that for making flakes.

The highest number of tools was done on flakes, followed by blades, then bladelets, cores, chunks and core rejuvenation flakes (Table 5).

When viewed as a whole, almost the entire operational sequence has been recorded in LP II, from procurement of raw materials to discarding of tools.[37] The image of operational sequence would have been somewhat different if different groups of raw materials were considered separately. In this case, perhaps not all phases would have been present in individual raw material categories, particularly if one takes into account the (potentially) relatively great distance of (possible) assumed sources of raw materials, but this shall be the subject of future research.

37 Pronađena su svega dva odbojčića (< 1 cm), koji mogu biti nusprodukt finalne izrade ili dotjerivanja alatki na samom nalazištu, a pribrojeni su kategoriji odbojaka zbog malog broja pronađenih komada. Njihov mali broj vjerojatno je posljedica neprosijavanja sedimenta.

37 Only two small flakes (< 1 cm) were found, and they may have been the by-product of final retouching or refinement of a tool at the find-site itself; they were added to the flake category due to the small number of pieces found. Their small number is probably due to the lack of sifting of the sediments.

litička faza II (▼140 - 300 cm)		
Tip alatke	**kom.**	**%**
noktoliko grebalo	157	17,01
kružno grebalo	7	0,76
grebalo na odbojku	125	13,54
grebalo na sječivu/pločici	12	1,30
pločica s hrptom	18	1,95
zakrivljeni šiljak s hrptom	10	1,08
mikrograveta	2	0,22
kružni segment	2	0,22
pravokutnik	1	0,11
zarubak	11	1,19
strugalo	104	11,27
svrdlo	17	1,84
dubilo	17	1,84
iskrzani komadić	78	8,45
komadić sa sitnom rubnom obradom	17	1,84
komadić s obradom	199	21,56
nazubak	125	13,54
udubak	14	1,52
ulomak s obradom	7	0,76
ukupno	**923**	**100,00**

Tablica 6.
Litička faza II - tipologija

lithic phase I (▼140 - 300 cm)		
Tool type	**pcs.**	**%**
thumbnail endscraper	157	17.01
circular endscraper	7	0.76
endscaper on flake	125	13.54
endscraper on blade/bladelet	12	1.30
backed bladelet	18	1.95
curved backed point	10	1.08
micro-Gravette	2	0.22
segment	2	0.22
rectangle	1	0.11
truncation	11	1.19
sidescraper	104	11.27
borer	17	1.84
burin	17	1.84
splintered piece	78	8.45
marginally retouched piece	17	1.84
retouched piece	199	21.56
denticulate	125	13.54
notch	14	1.52
retouched fragment	7	0.76
total	**923**	**100.00**

Table 6.
LLithic phase II - typology

5.4. Litička faza II - tipologija (sl. 5, 6 i 7)

U LF II definirano je 18 tipova alatki. Najbrojniju skupinu čine grebala, s učestalošću od 32,61 %. Među grebalima najbrojnija su noktolika, slijede grebala na odbojku, zatim grebala na sječivu/pločici i kružna grebala (tablica 6).

U ovoj fazi pločica s hrptom (1,95 %) gotovo je dvostruko više od zakrivljenih šiljaka s hrptom (1,08 %). Sve pločice s hrptom unilateralno su strmo retuširane. Za ovu fazu karakteristična je prisutnost 2 mikrogravete (0,22 %) koje se ne javljaju u ranijoj fazi (LF I). Komadi s obradom čine najzastupljeniji pojedinačni tip, s učestalošću od 22,56 %. Brojni su i nazupci (13,54 %), strugala (11,27 %), iskrzani komadići (8,45 %). Od geometrijskih mikrolita zabilježena su dva kružna segmenta (0,22 %) i jedan pravokutnik (0,11 %). Kao i mikrogravete, pravokutnik je tip alatke koji se javlja samo u ovoj mlađoj fazi.

6. Usporedba LF I i LF II

LF I i LF II pokazuju znatnu tehnološku sličnost. Odbojci su dominantna tehnološka kategorija, s učestalošću iznad 50 % u obje faze. Krhotine su nakon odbojaka najzastupljenija kategorija, s učestalošću od 18,75 % u LF I i 22,17 % u LF II. Učestalost i ostalih tehnoloških kategorija gotovo je u potpunosti podudarna u obje faze (vidi tablice 3 i 5).

Tipološka varijabilnost LF I i LF II vrlo je slična. U LF I definirano je 17 tipova alatki, a u LF II 18. Svaka od ove dvije faze ima tipove karakteristične samo za pojedinu fazu. Tako se samo u LF I javljaju gravetijenski šiljci, a u LF II mikrogravete i pravokutnik. Ostali tipovi alatki javljaju se u obje faze.

5.4. Lithic phase II - typology (Fig. 5, 6 and 7)

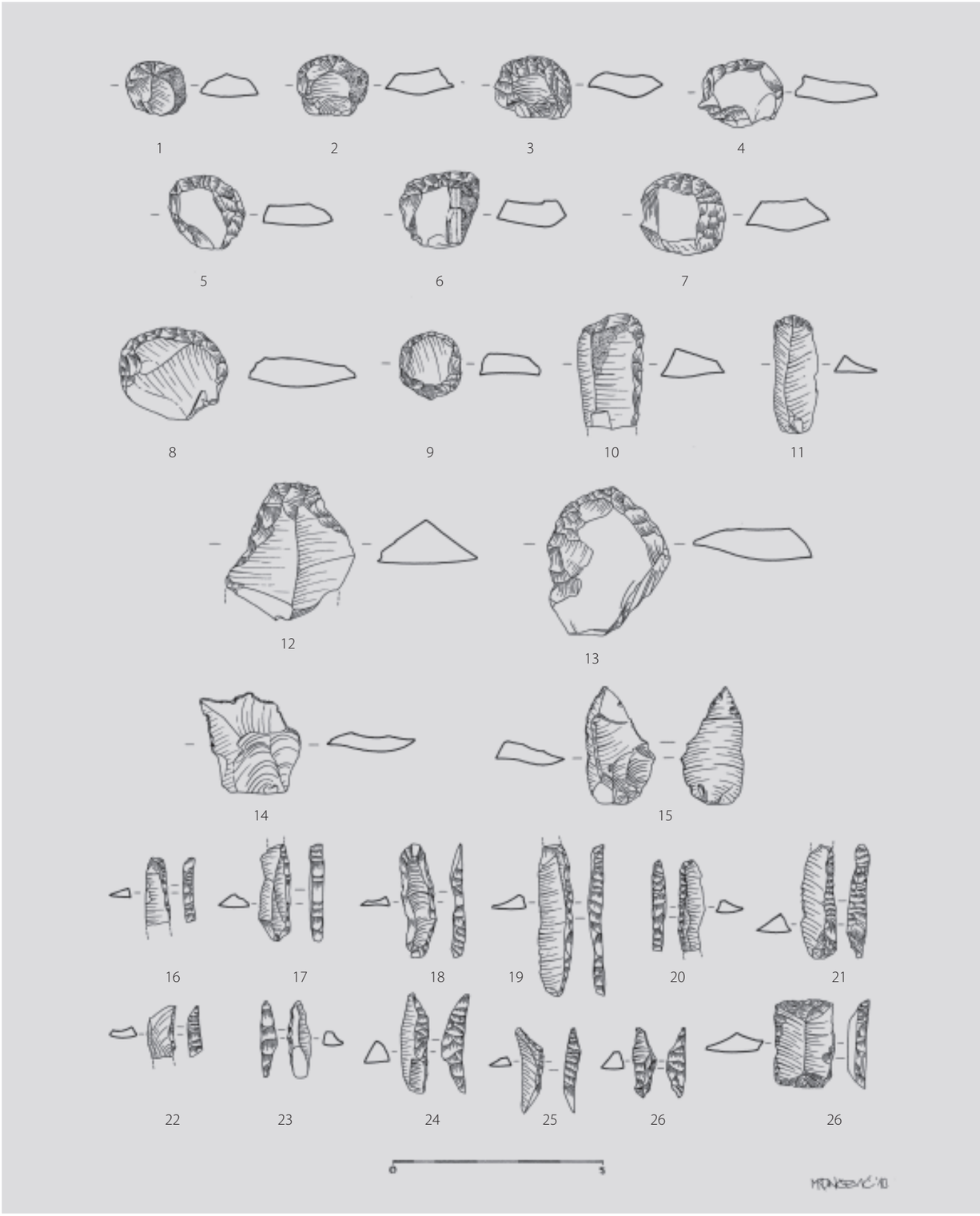
18 tool types were defined in LP II. The most numerous group of tools consists of endscrapers, with a frequency of 33.61%. Among the endscrapers, the most numerous are thumbnail endscrapers, followed by endscrapers on flakes, and then endscrapers on blades/bladelets and circular endscrapers (Table 6).

In this phase, there are almost twice as many backed bladelets (1.95%) as there are curved backed points (1.08%). All backed bladelets are unilaterally retouched. The presence of two micro-Gravettes (0.22%), which do not appear in the earlier phase (LP I), is characteristic of this phase. Retouched pieces are the most common individual type, with a frequency of 22.56%. Also numerous are denticulates (13.54%), sidescrapers (11.27%), and splintered pieces (8.45%). Among the geometric microliths, two segments (0.22%) and one rectangle (0.11%) are present. Like the micro-Gravettes, the rectangle is a type of tool which appears only in this younger phase.

6. Comparison of LP I and LP II

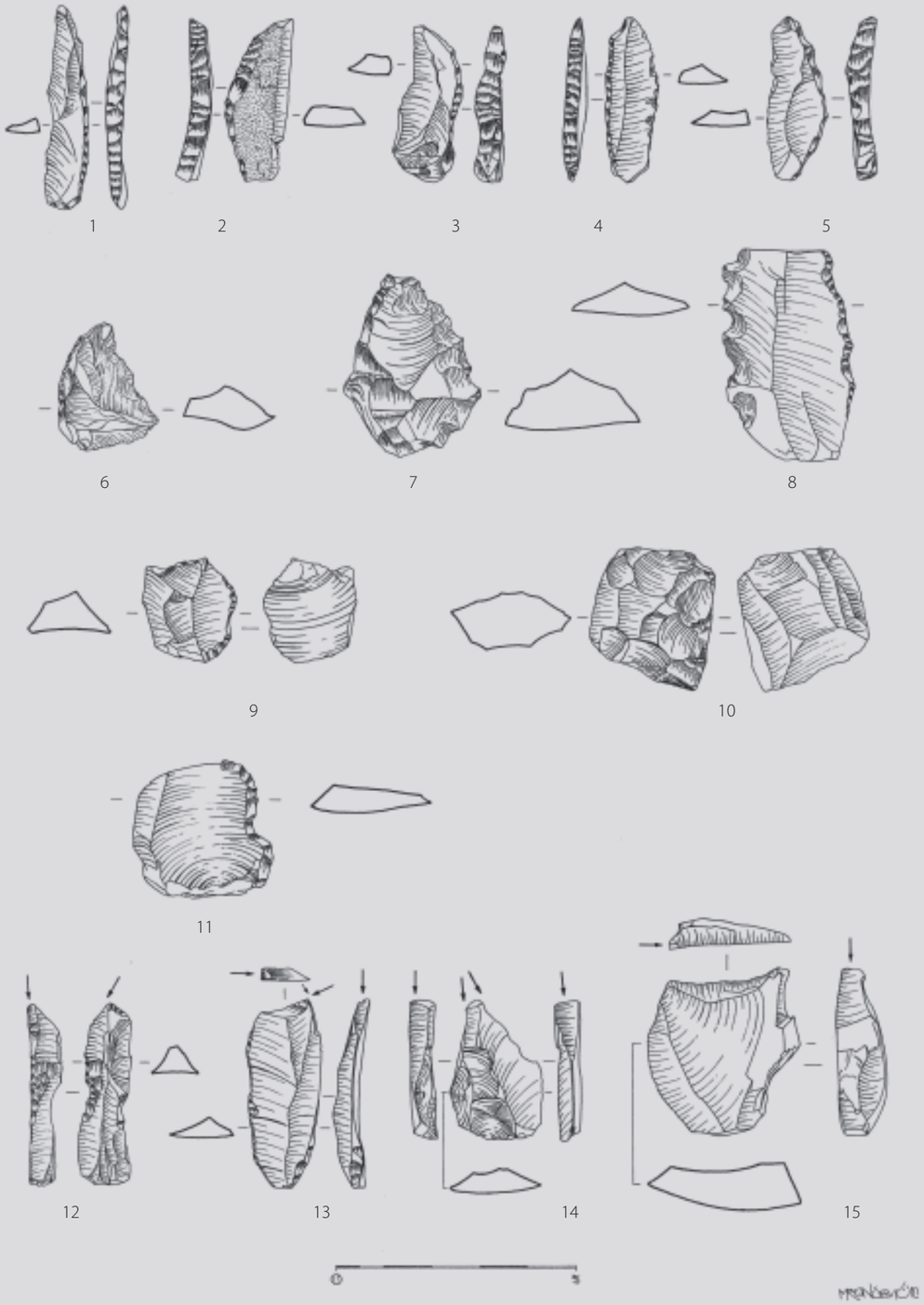
LP I and LP II exhibit considerable technological similarity. Flakes are the dominant technological category with a frequency higher than 50% in both phases. After flakes, chunks are the most common category with frequency of 18.75% in LP I and 22.17% in LP II. The frequency of other technological categories almost entirely corresponds in both phases (see Table 3 and 5).

The typological variability of LP I and LP II is quite similar. In LP I, 17 tool types have been defined, while 18 have been defined in LP II. Each of these two phases contains types characteristic of only an individual phase. Thus, Gravettian points appear only in LP I, while micro-Gravettes and a rectangle appear in LP II. The remaining tool types appear in both phases.



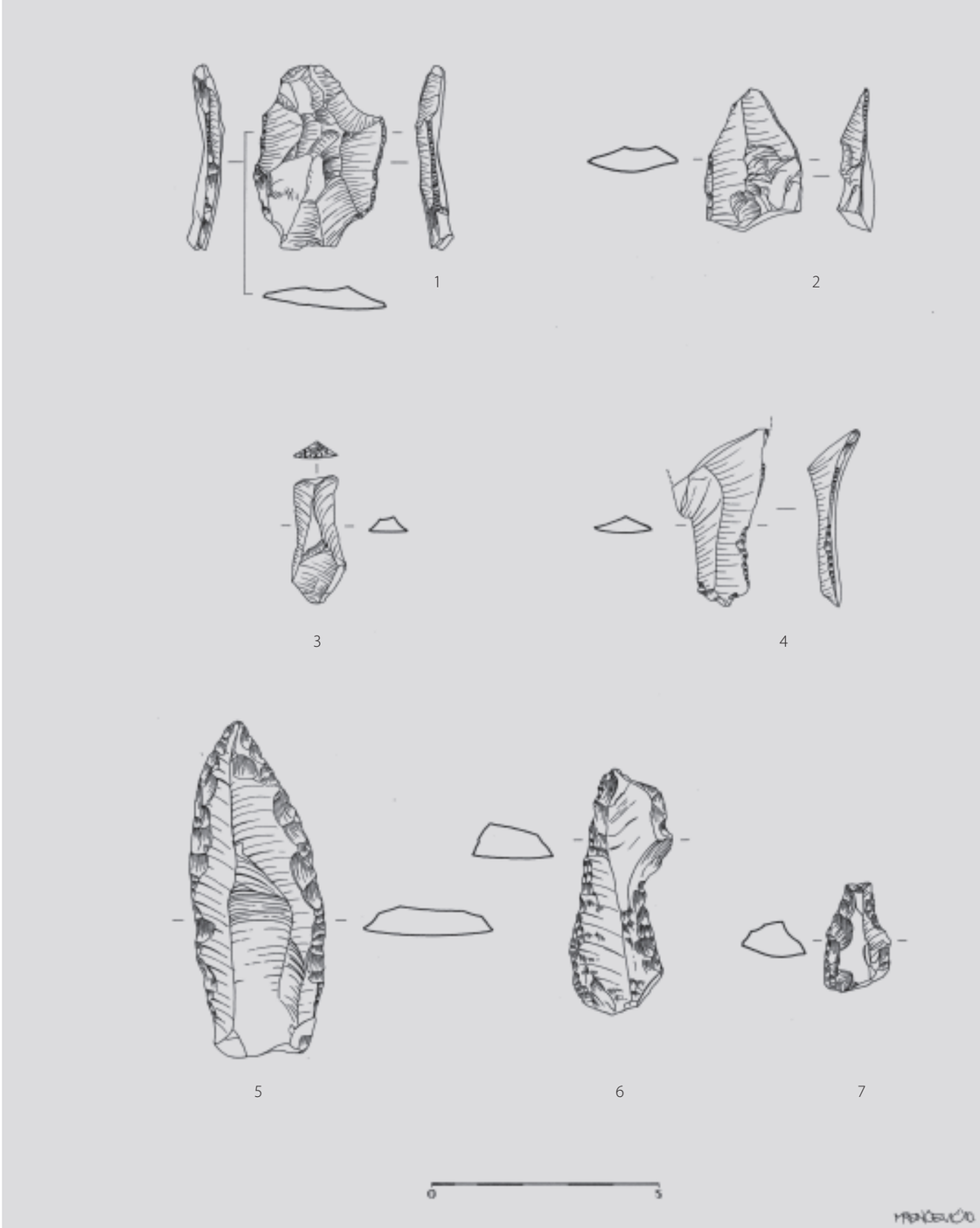
Slika 5.
Izbor kamenih alatki iz litičke faze II. 1-8: noktolika grebala, 9: kružno grebalo, 10, 11: grebala na sječivu/pločici, 12, 13: grebala na odbojku, 14, 15: svrdla, 16-22: pločice s hrptom, 23, 24: mikrogravete, 25, 26: kružni segmenti, 27: pravokutnik

Figure 5.
Selection of stone tools from lithic phase II. 1-8: thumbnail endscrapers, 9: circular endscraper, 10, 11: endscrapers on blades/bladelets, 12, 13: endscrapers on flakes, 14, 15: borers, 16-22: backed bladelets, 23, 24: micro-Gravettes, 25, 26: segments, 27: rectangle



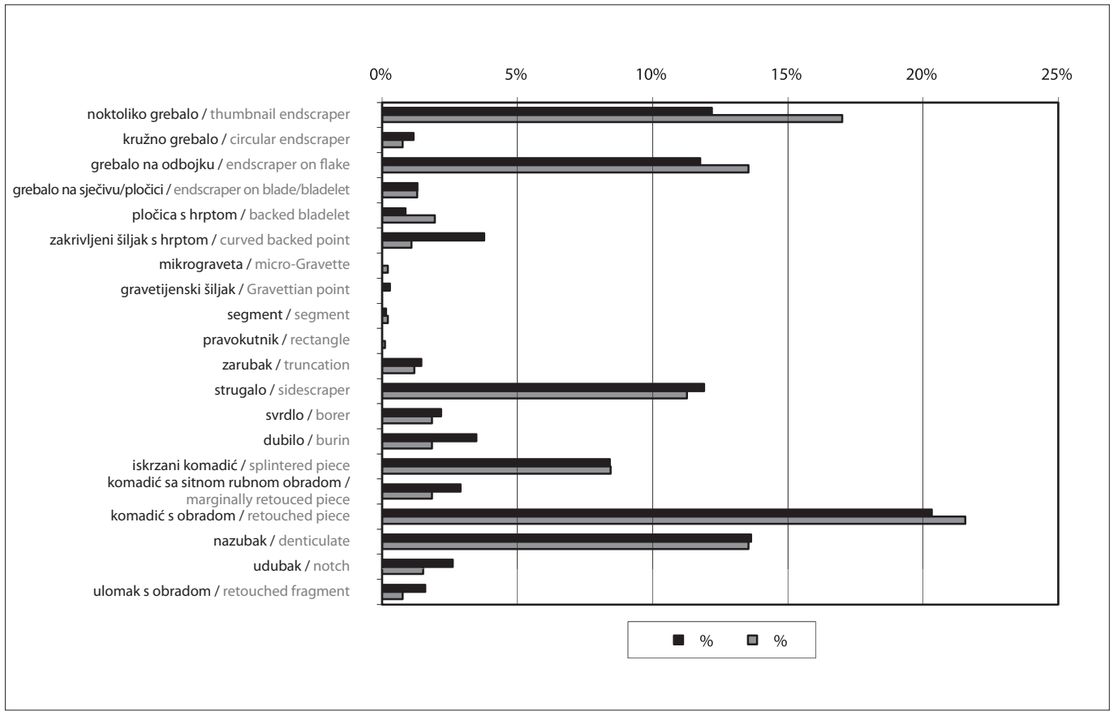
Slika 6.
Izbor kamenih alatki iz litičke faze II. 1-5: zakrivljeni šiljci s hrptom, 6-8: nazupci, 9, 10: iskrzani komadići, 11: udubak, 12-15: dubila

Figure 6.
Selection of stone tools from lithic phase II. 1-5: curved backed points, 6-8: denticulates, 9, 10: splintered pieces, 11: notch, 12-15: burins



Slika 7.
Izbor kamenih alatki iz litičke faze II. 1, 2: komadići sa sitnom rubnom obradom, 3: zarubak, 4: komadić s obradom, 5-7: strugala

Figure 7.
Selection of stone tools from lithic phase II. 1, 2: marginally retouched pieces, 3: truncation, 4: retouched piece, 5-7: sidescrapers



Slika 8.
Usporedba učestalosti tipova alatki u litičkoj fazi I i litičkoj fazi II

Figure 8.
Relative frequency comparison of tool types in lithic phase I and lithic phase II

Noktolika grebala, iako su najzastupljenija među grebalima u obje faze, brojnija su u LF II. Geometrijski mikroliti prisutni su u obje faze, ali je njihova učestalost veća u LF II. Odnos pločica s hrptom i zakrivljenih šiljaka s hrptom u ove dvije faze, poslužio je kao kriterij za njihovo odvajanje, a već je prije spomenut. Učestalost zarubaka, strugala, svrdla, iskrzanih komadića, komadića s obradom, nazubaka i udubaka vrlo je slična. Uspoređujemo li relativnu učestalost dubila, ona su u LF II manje zastupljena (1,84 %) negoli u LF I (3,48 %) (sl. 8). Iako postoje određene razlike, ove dvije faze su vrlo slične i pokazuju vrlo male razlike protokom vremena. Razlike u litičkom materijalu mogle su biti uvjetovane trenutnim potrebama i aktivnostima lovaca i skupljača koji su boravili u Kopačini. Važno je istaknuti da ni među ostacima faune u Kopačini ne postoje značajne promjene tijekom vremena. Najbrojniji su ostaci jelena (*Cervus elaphus*), nakon čega slijede ostaci divljeg magarca (*Equus hydruntinus*) tijekom čitavog stratigrafskog slijeda.[38]

7. Petrografski tipovi korištene sirovine
7.1. Skupina crvenih radiolarita

Od ukupno 4600 nalaza, 162 nalaza ili 3,52 % su crveni radiolariti, sa 2,67 % težinskog udjela u ukupnoj masi ispitanih artefakata koja iznosi 22.366,39 grama (sl. 9).

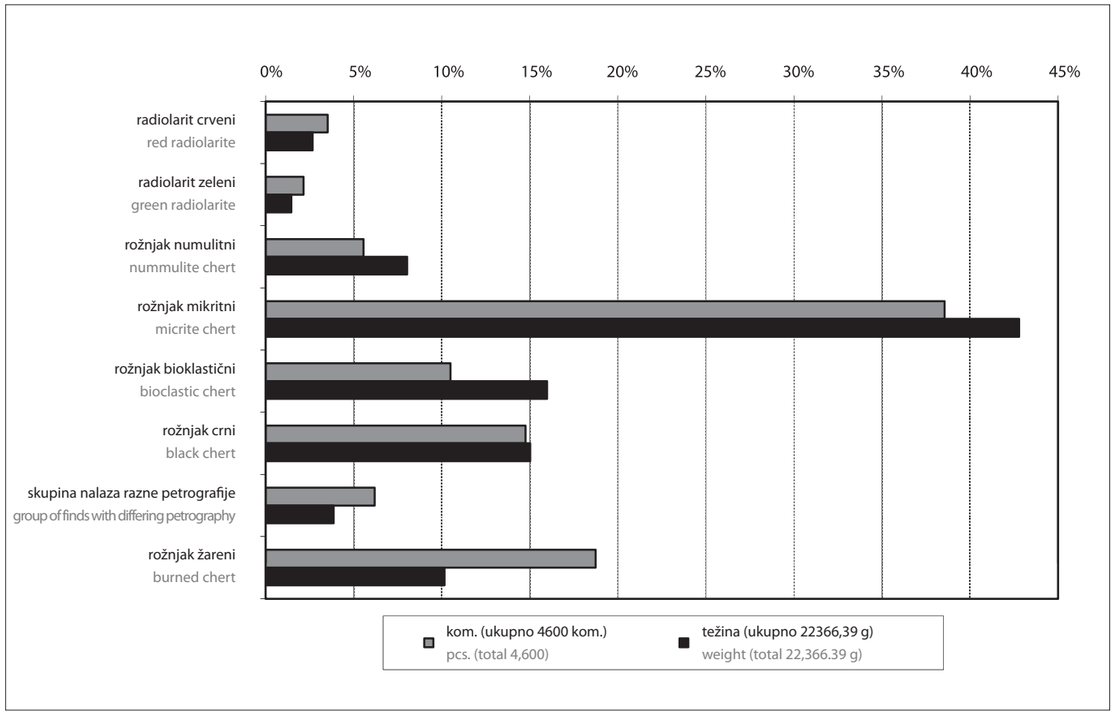
38 Miracle 1996, str. 50-53.

Thumbnail endscrapers, although most common among the endscrapers in both phases, are more numerous in LP II. Geometric microliths are presentin both phases, but their frequency is greater in LP II. The ratio of backed bladelets to curved backed points in both phases served as the criterion for distinguishing them, as already mentioned previously. The frequency of truncations, sidescrapers, borers, splintered pieces, retouched pieces, denticulates and notches is very similar. If the relative frequency of burins is compared, they are less frequent in LP II (1.84%) than in LP I (3.48%) (Fig. 8). Although there are certain differences, these two phases are very similar and exhibit very little variation over time. The differences in lithic materials may have been dictated by the momentary needs and activities of the hunter-gatherers who resided in Kopačina. Worth emphasizing is that there are no significant changes over time among animal remains either. The most numerous are remains of red deer (*Cervus elaphus*), followed by remains of European ass (*Equus hydruntinus*), over the course of the entire stratigraphic sequence.[38]

7. Petrographic types of raw materials used
7.1. Red radiolarite group

Out of the total 4,600, 162 finds or 3.52% are red radiolarites with a 2.67% weight share in the total mass of the examined artefacts, which is otherwise 22,366.39 g (Fig. 9).

38 Miracle 1996, pp. 50-53.



Slika 9.
Brojčana i težinska učestalost petrografskih skupina korištene sirovine iz Kopačine

Figure 9.
Numerical and weight frequency of petrographic groups of used raw materials from Kopačina

Artefakte izrađene od crvenog radiolarita relativno je lako prepoznati i preliminarno ih petrografski odrediti jer se kamen ističe tipičnom pastelnom bojom, prigušenim sjajem i neprozirnošću, a nerijetko su pod povećalom vidljivi fosili radiolarija.[39] Kopačinski crveni radiolaritni nalazi raznih su stupnjeva zasićenja i intenziteta crvenih, crvenosmeđih i žutosmeđih tonova,[40] voštanog sjaja i slabe svjetlopropusnosti ili su sasvim svjetlonepropusni.[41] Petrografski zreliji, tj. jače silicificirani primjerci imaju izražen konkavno-konveksan lom i

39 Radiolarit (engl. *radiolarite*, *radiolarian chert*) je biogeni varijetet rožnjaka koji nastaje litificiranjem dubokomorskih (ispod CCD-crte) silicijskih muljeva bogatih radiolarijama. Radiolarit je tvrda i gusta stijena, oštrobridnog školjkastog loma, voštanog sjaja, svjetlonepropusna, crvenih i crvenosmeđih tonova, rjeđe zelenih i sivozelenih, dok je lidit (engl. *lydite*) crne boje (Füchtbauer, Müller 1970, str. 487). Za radiolarite bi trebalo izbjegavati izraz "radiolarijski rožnjak" (eng. *radiolarian chert*) jer se taj izraz rabi za tip metasomatskog rožnjaka koji obiluje fosilima radiolarija (usp. Tišljar 2001, str. 46).

40 Crvenu boju radiolaritima, tipičnu za europski varijetet, daje uklopljeni hematit koji potječe od crvenice isprane u sedimentacijski bazen. Sivozelenu boju daju minerali iz skupine klorita, odnosno prevlast dvovalentnog željeza nad trovalentnim u sedimentu (Grunau 1965, str. 196).

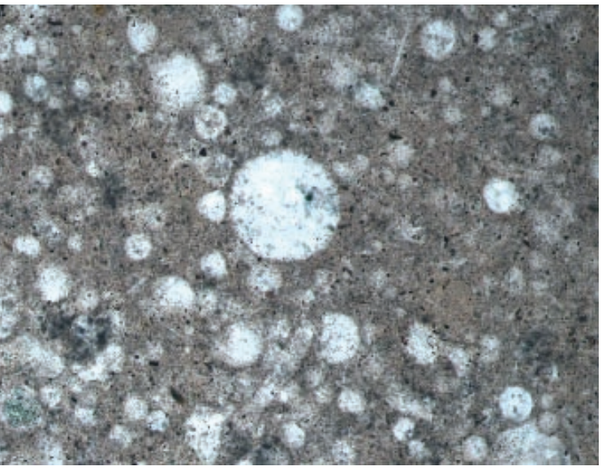
41 Stupnjevi transparentnosti: *opaque* ili svjetlonepropusno, slabo svjetlopropusno na rubu, svjetlopropusno na rubu, svjetlopropusno, svjetlopropusno-prozirno, prozirno.

Artefacts made of red radiolarite are rather easy to recognize and also to specify petrographically, because the stone exhibits a typical pastel colour, subdued lustre and opacity, while radiolarian fossils are not rarely visible under a magnifying glass.[39] The Kopačina red radiolarite finds exhibit varying degrees of saturation and intensity of red, red-brown and yellow-brown tones,[40] a waxy lustre and meagre translucence, or they are completely translucent.[41] The petrographically more mature, i.e. more silicified, examples have marked concave and convex fraction and they are harder than those

39 Radiolarite (radiolarian chert) is a biogenetic variety of chert which emerges by lithification of deep-sea (below the CCD-line) silicate mud rich in radiolaria. Radiolarite is a hard and dense rock, with sharp-edged, shell-like fraction, waxy lustre, translucent, red and red-brown tones, more rarely green and grey-green, while lydite is black (Fürchtbauer, Müller 1970, p. 487). In case of radiolarite, the term "radiolarian chert" should be avoided, for this is used for a type of metasomatic chert which abounds in fossil radiolaria (cf. Tišljar 2001, p. 46).

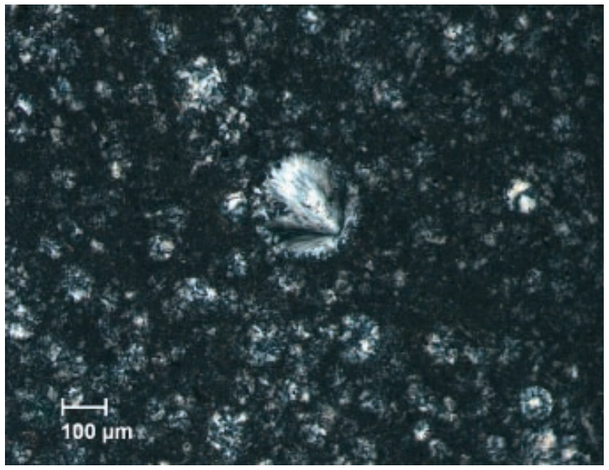
40 The red colour in radiolarites, typical of the European variety, is provided by incorporated haematite which originates in red soils weathered in sedimented basins. The grey-green colour is provided by the minerals of the chlorite group, i.e. the predominance of divalent iron over the trivalent variety in the sediment (Grunau 1965, p. 196).

41 Degrees of transparency: opaque or translucent, poorly translucent at the edge, translucent at the edge, translucent, translucent-transparent, transparent.



Slika 10.
Crveni radiolarit. Polarizacijski mikroskop, polarizirano svjetlo

Figure 10.
Red radiolarite. Polarized light microscope, polarized light



Slika 11.
Crveni radiolarit. Polarizacijski mikroskop, ukršteni nikoli

Figure 11.
Red radiolarite. Polarized light microscope, crossed polars

tvrđi su od onih grublje strukture koja je znak trošnosti kamena ili značajnijeg udjela minerala susjedne stijene.[42] Zrnatost nije uočljiva prostim okom, bridovi su glatki i oštri. Tvrdoća kamena onih nalaza koji su sasvim silicificirani je 6,5 do 7 prema Mohsovoj skali.[43] Tehnička kakvoća kamena većine nalaza iz ove skupine je vrlo dobra i odlična.[44] Pri petrografskom određivanju radiolarita pod povećalom s povećanjem od 10 puta, moguće je vidjeti točkice promjera oko 0,2 mm, rijetko prostim okom. Bijele točkice, gotovo redovito pravilni krugovi, otisci su skeleta radiolarija čija je fosilna šupljina najčešće zapunjena kalcitom iz pornih voda, dok crne točkice predstavljaju fosilne ostatke radiolarija, skeleta primarno izgrađenih od opala-B, koji u dijagenezi sedimenta rekristalizira u kriptokristalni kvarc ili vlaknasti kalcedon.[45] Mikroskopirani primjerci pokazuju neujednačenu strukturu i nejednako očuvane fosile radiolarija (sl. 10).[46]

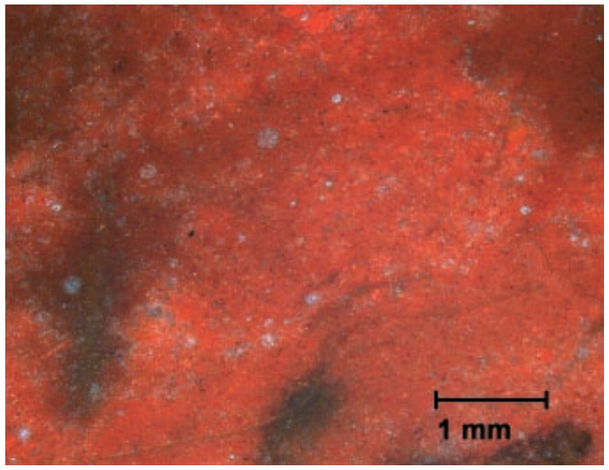
Fosili radiolarija prepoznaju se po pravilnim kružnim ili elipsoidnim nakupinama ispunjenim fibroznim i sferulitnim kalcedonom u gustom mikrokristalnom i kriptokristalnom kvarcnom matriksu (sl. 11).[47]

42 U takvim je primjercima slika fosila jasnija jer su radiolarije manje rekristalizirane.
43 Relativna tvrdoća prema paranju mjeri se ispitnim štapićima s mineralnim zrnima određene tvrdoće.
44 Stupnjevi tehničke kakvoće kamena: loša, dobra, vrlo dobra, odlična.
45 Radiolarije su planktonske protozoe rhizopoda koje svoje skelete grade od opala (amorfne silicijske kiseline, $SiO_2 x nH_2O$). Fosilno sačuvani ostaju najčešće obrisi (tragovi radijalnih pseudopodija) krupnijih skeleta uginulih planktona (kuglasta ili diskoidna vrsta spumellaria i stožasta nassellaria, φ 0,005-0,25 mm), litificirani u radiolarijskom mulju koji nastaje sedimentiranjem rastvorenih sitnijih skeleta (Füchtbauer, Müller 1970, str. 479).
46 Sve mikrosnimke izradio Z. Perhoč 2010.
47 Na nabrusku s binokularnim i u izbrusku s polarizacijskim mikroskopom.

coarser structures, which is an indication of the poor condition of the stone or a significant share of minerals from neighbouring stones.[42] Granularity is not visible to the naked eye, and the edges are smooth and sharp. The hardness of the stone of those finds that are entirely silicified is 6.5 to 7 according to the Mohs scale.[43] The technical quality of the stone in most of the finds from this group is very good to excellent.[44] When petrographically determining radiolarites under a scope with a magnification factor of 10, it is possible to see dots with a diameter of 0.2 mm, which can rarely be seen with the naked eye. White dots, almost always regular circles, are the imprints of radiolarian skeletons, whose fossil cavities were most often filled with calcite from pore water, while the black dots are the fossils remains of radiolaria, skeletons primarily composed of opal-B, which in the diagenesis of the sediment recrystallizes into cryptocrystalline quartz or fibrous chalcedony.[45] Microscopic examples indicate a non-uniform structure and unequally preserved fossil radiolaria (Fig. 10).[46]

Radiolarian fossils are recognized by the regular circular or ellipsoidal accretions filled with fibrous and spherulite chalcedony

42 In such examples, the picture of the fossils is clearer, because the radiolaria are less recrystallized.
43 Relative hardness based on scratch resistance is measured by a test rod with mineral grains of specified hardness.
44 Degrees of technical quality of stone: poor, good, very good, excellent.
45 Radiolaria are plankton rhizopod protozoa which build their skeletons from opal (amorphous silicic acid, $SiO_2 x nH_2O$). Most often the fossilized remains consist of the contours (traces of radial pseudopodia) of larger skeletons of dead plankton (spherical or discoid species of Spumellaria and conical Nassellaria, φ 0.005-0.25 mm), lithified in radiolarian mud which emerges by sedimentation of decomposed tiny skeletons (Fürchtbauer, Müller 1970, p. 479).
46 All microscopic images made by Z. Perhoč 2010.



Slika 12.
Crveni radiolarit. Binokularni mikroskop, nabrusak

Figure 12.
Red radiolarite. Binocular microscope, polished section

Pod većim povećanjem relikti pseudopodija radiolarija vidljivi su kao nazubljeni rubovi fosila. Radiolarije dobro vidljive u izbrusku, moguće je uočiti već na nabrusku (sl. 12).

Primjerci koji makroskopski u svemu odgovaraju radiolaritnoj stijeni, bez jasno vidljivih radiolarija na nabrusku ili s tek vidljivim "duhovima" fosila, pridruženi su istoj skupini.[48] Radiolaritne stijene često su tektonski poremećene, raspucane okomito na taložnu plohu i prošarane bijelim, crnim, narančasto-žućkastim, zelenkastoplavim žilicama koje nastaju cementiranjem tako nastalih pukotina kalcedonom ili mikrokristalnim kvarcom, nerijetko i kalcitom. Na manjem broju nalaza vidljiva je valutična okorina posuta udarnim napuklinama[49] (10 odbojaka, dvije jezgre i jedna velika krhotina), što dokazuje da su tehnološke jezgre preparirane od dobro zaobljenih valutica i da je barem dio radiolaritnih artefakata proizveden *in situ*.[50]

48 U radiolaritima fosili radiolarija nisu uvijek prisutni ili vidljivi (usp. Füchtbauer, Müller 1970, str. 487-491.). Za nomenklaturu pojmova "radiolarit", "radiolarijski rožnjak", vidi u Halamić, Šošić Klindžić 2009, str. 20.
49 Udarne napukline, engl. *impact marks*, *crush marks*, *percusions marks*, *crescentic impact marks* (Pettijohn 1957, str. 71), njem. *Rindenvernarbung*, *Schlagnarben*, *Vernarbung der Rinde* (Floss 1994, str. 98, 99), sporedna je petrografska strukturna značajka kore krupnijeg šljunčanog zrna, valutica i oblutaka. Te napukline su površinski lik konkavno-konveksnog loma (tzv. školjkasti lom) na valutičnoj kori tvrdih, sitnozrnih i homogenih uglavnom silicijskih ili silicificiranih stijena. Do napuknuća kamena dolazi u procesu trošenja stijena, tijekom fluvijalnog ili marinskog transporta u vodi visoke energije, kad se lom uzrokovan udarcem kamena o kamen nema prilike potpuno razviti, tj. kad se udareni i pritisnuti dio kamena ne odlome, a lomna brazda bude "zaustavljena", odnosno kad je kinetička sila podređena inerciji mase kamena.
50 Stupnjevanje zaobljenosti po modelu Russel-Taylor-Pettijohn (Müller 1964, str. 108).

in a dense micro- and cryptocrystalline quartz matrix (Fig. 11).[47]

Under greater magnification, relics of radiolarian pseudopodia are visible as serrated fossil edges. Radiolaria are easily visible in the thin-section, and already noticeable on the polished section (Fig. 12).

Examples that macroscopically correspond to radiolarite rock in all aspects, without clearly visible radiolaria on the thin-section or only with discernable "phantoms" of fossils, were put together in the same group.[48] Radiolarite rocks are often tectonically damaged, vertically fissured on the deposit surface and interspersed with white, black, orange-yellow and green-blue veins which are created by the cementing of such fissures by chalcedony or microcrystalline quartz, and, occasionally, calcite as well. A rind of pebbles with scattered impact marks[49] is visible on a smaller number of finds (10 flakes, 2 cores and 1 large chunk), which demonstrates that technological cores were prepared from well rounded pebbles and that at least some of the radiolarite artefacts were produced *in situ*.[50]

Consequently, the red radiolarite used in the Kopačina products was gathered at allochthonous outcrops, in gravel. Based on the spherical nature of the weathering rinds, we postulate that these were pebbles with granulometry of medium gravel.[51] There are no autochthonous radiolarite deposits on the islands, nor in Dalmatia's coastal belt. An insular allochthonous outcrop of radiolarite pebbles is highly unlikely,[52] while there is no reason to speak of Apennine[53] and Pannonian-Carpathian[54] deposits, so following the principle of nearer to farther, we may take into consideration deposits and outcrops in the nearer and more remote hinterland and the lands on the Eastern Adriatic side. Conglomerates containing radiolarite (and chert) components are

47 On polished section with binocular microscope and thin-section with polarized light microscope.
48 In radiolarites the radiolarian fossils are not always present nor visible (cf. Fürchtbauer, Müller 1970, pp. 487-491). For the nomenclature terms "radiolarite" and "radiolarian chert", see Halamić, Šošić Klindžić 2009, p. 20.
49 Impact marks, also crush marks, percussion marks, crescentic impact marks (Pettijohn 1957, p. 71), Cro. *udarne napukline*, Germ. *Rindenvernarbung*, *Schlagnarben*, *Vernarbung der Rinde* (Floss 1994, 98, 99), are ancillary petrographic structural traits of the crust of larger gravel grains, pebbles and cobbles. These marks are the surface image of concave-convex fraction (so-called shell fraction) on the pebbled crust of hard, fine-grain and homogenous, generally siliceous or silicified rocks. Cracks in the stone appear during the process of weathering of the rock, during fluvial or marine conveyance in high-energy water when the breakage caused by rocks striking each other does not have the opportunity to expand, and the break fissure is "halted", i.e., the kinetic force is subordinated to the inertia of the stone's mass.
50 Grading of roundness based on Russel-Taylor-Pettijohn model (Müller 1964, p. 108).
51 Pebbles, specification according to Wentworth's granulometric scale, dimensions from 4 to 64 mm (Müller 1964, p. 57).
52 Perhoč, in preparation.
53 Maggi et al. 1995, p.187.
54 Biro et al. 2009.

Prema svemu ovome, crveni radiolarit je za kopačinske izrađevine bran na izdancima alohtonog tipa, u šljuncima. Prema sferičnosti valutičnih okorina procjenjujemo da se radilo o valuticama granulometrije srednjeg šljunka.[51] Autohtonih ležišta radiolarita na otocima nema, kao ni u obalnom pojasu Dalmacije. Otočni alohtoni izdanak radiolaritnih valutica malo je vjerojatan[52], o apeninskim[53] i panonsko-karpatskim[54] ležištima nemamo povoda diskutirati, stoga slijedom principa od bližeg prema daljem uzimamo u obzir ležišta i izdanke u bližem i daljem zaleđu i zemljama na istočnoj jadranskoj strani.

Konglomerati s radiolaritnim (i rožnjačkim) komponentama malo su vjerojatan izvor sirovine, i to samo u slučaju erodiranih valutica iz takvih stijena. Radiolarijske valutice iz prominskih konglomerata zabilježene su kod Drivenika u Vinodolu.[55] Konglomerati na području južnog Velebita pored rožnjačkih sadrže i radiolarijske valutice.[56] Arheološka relevantnost navedenih izdanaka nije nam poznata. Izdanak konglomerata tipa Promina kod Benkovca i Šopota, prema našim zapažanjima, sadrži vrlo istrošene i arheološki uglavnom nevažne rožnjačke komponente, dok radiolaritne valutice nismo zapazili.[57] Međutim, valutice radiolarita i drugih silicijskih i silicificiranih stijena arheološki relevantne kakvoće, količine i dostupnosti, zapazili smo u kvartarnom sedimentu Ravnih kotara kod Ražanca, nastalim vjerojatno erozijom okolnih konglomerata.[58]

Vjerojatniji izvor kopačinskih radiolaritnih valutica je rijeka Neretva. Pretraživanjem recentnog nanosa i terasa (u šljunčarama) Neretve na nekoliko mjesta, kod Čeljeva i drugdje uzvodno do Počitelja, odnosno do utoka Drežanke u Neretvu u Bosni i Hercegovini, osim nekoliko tipova rožnjaka u šljunku smo ustanovili manju koncentraciju crvenog (crveno-zelenog i crnog) radiolarita solidne kakvoće.[59] Ako je radiolarit u prapovijesti bran na Neretvi, to je moglo biti na šljunku akumuliranom na obali, na prudovima ili na riječnoj terasi bilo kojeg dijela njezina toka, te u gornjoj lepezi delte rijeke. Tijekom kasnoglacijalnog maksimuma delta Neretve ležala je u Korčulanskom kanalu, vjerojatno nedaleko od linije današnjeg otoka Šćedra kod Hvara i u tada još neotočni dalmatinski bazen naplavljivala golemu količinu šljunka.[60] Reljef kasnoglacijalnog jadranskog okoliša, bitno drugačijeg izgleda od današnjeg zbog znatno niže morske razine, ostavlja otvorenim mogućnost prikupljanja sirovine iz šljunka Paleoneretve na prostoru koji je danas potopljen.

Sljedeći mogući izvor radiolarita korištenog u prapovijesnoj litičkoj industriji su izdanci u zoni Budva koja se proteže od Herceg Novog (najsjeverniji izdanci isklinjavaju u Konavlima) do Sutomora u Crnoj Gori i dalje na jug do Grčke.[61] Brojni su izdanci radiolarita na obroncima crnogorskoprimorskih planina u pojasu širokom nekoliko kilometara koji dopire do obale, ulazi u more i nastavlja se na obližnjim otočićima. Na žalu obale kod Herceg Novog, a naročito na potezu od Budve do Svetog Stefana, zabilježili smo veliku koncentraciju valutica i oblutaka od crvenog radiolarita. Pristupačnost tih crnogorskih izdanaka, obilatost radiolarijskih valutica i oblutaka na žalu vrlo dobre do odlične tehničke kakvoće, svakako treba uzeti u obzir kao mogući izvor sirovine u prapovijesnoj litičkoj proizvodnji u našem radnom prostoru i šire.

Ipak, najvjerojatniji izvor valutica od kojih su izrađeni kopačinski radiolaritni artefakti jesu šljunčani agregati rijeka i potoka u središnjoj ofiolitnoj zoni unutrašnjih Dinarida.[62] U ofiolitnom melangeu, koji zauzima najveći prostor kompleksa Krivaja-Konjuh[63] u ofiolitnoj zoni, pored ostalih stijena u šejl-siltnom matriksu, ima i radiolarita.[64] Jakob Pamić za stijene radiolarita koje je moguće kartirati u kontekstu svjetskog ofiolitskog kompleksa, uvodi termin "radiolarit formacija". Radiolarit formacija se pojavljuje duž krajnje jugozapadne margine

a rather improbable source of raw materials, and only in the case of eroded pebbles from such rocks. Radiolarian pebbles from Promina conglomerates have been recorded at Drivenik, in Vinodol.[55] Conglomerates on the territory of southern Velebit contain, besides chert, radiolarian pebbles as well.[56] The archaeological relevance of these outcrops is not known. The outcrop of Promina-type conglomerates at Benkovac and Šopot contain, based on our observations, very worn and archeologically generally negligible chert components, while we noted no radiolarite pebbles.[57] However, pebbles of radiolarite and other siliceous and silicified rocks of archeologically relevant quality, quantity and accessibility have been noticed in the quaternary sediment of Ravni Kotari at Ražanac, probably created by the erosion of the surrounding conglomerates.[58]

The more likely source of the Kopačina radiolarite pebbles is the Neretva River. Upon examination of recently formed alluvium and terraces (in gravel pits) along the Neretva at several places, at Čeljevo and elsewhere upstream to Počitelj, i.e., up to the mouth of the Drežanka into the Neretva in Bosnia-Herzegovina, we have ascertained, besides several types of chert, a small concentration of red (red-green and black) radiolarites of suitable quality in the gravel.[59] If radiolarite was gathered along the Neretva in prehistory, this may have been done on gravel accumulated on bar, on sand bars or on riverine terraces at any part of its course, in the upper fan of the river's delta. During the Late Glacial Maximum, the Neretva Delta lay in the Korčula Channel, probably not far from the line of today's island of Šćedro, near Hvar, and in the then as-yet non-insular Dalmatian basin composed of an enormous quantity of gravel.[60] The relief of the glacial Adriatic environment, essentially different from the appearance of today's due to the considerably lower sea level, left open the possibility of gathering raw materials from the paleo-Neretva's gravel in an area that is today submerged.

The next possible source of radiolarites used in the prehistoric lithics industry is the outcrops in the Budva zone, which extends from Herceg Novi (the northernmost outcrops protrude in Konavle) to Sutomore in Montenegro and farther south into Greece.[61] There are numerous outcrops of radiolarites on the foothills of Montenegrin mountains in a belt of several kilometres which reaches to the seashore, enters the sea and continues to the nearby islands. On the beach at Herceg Novi, and particularly along the stretch from Budva to Sveti Stefan, we have recorded a high concentration of red radiolarite pebbles and cobbles. The accessibility of these Montenegrin outcrops and the abundance of radiolarite pebbles on the beach, which are of very good to excellent technical quality, should certainly be taken into account as a possible source of raw materials for the prehistoric lithic industry in the relevant working area and beyond.

Nonetheless, the most likely source of the pebbles used to make the Kopačina radiolarite artefacts is the gravel aggregates of the rivers and streams in the central ophiolite zone of the Dinaric interior.[62] The ophiolite mélange, which occupies the largest space in the Krivaja-Konjuh complex[63] in the ophiolite zone, contains, besides other rocks in the shale-silt matrix, radiolarites as well.[64] Jakob Pamić introduced the term "radiolarite formation" for rocks which may be mapped in the context of the global ophiolite complex. The radiolarite formation appears all along the extreme south-west margins of the Dinaric ophiolite zone, together with igneous rock and fragments incorporated into the ophiolite mélange, and it borders with the Bosnian flysch. In some areas of

51 Valutice (engl. *pebble*), određenje prema granulometrijskoj skali Wentwortha, dimenzija od 4 do 64 mm (Müller 1964, str. 57).
52 Perhoč, u pripremi.
53 Maggi et al. 1995, str. 187.
54 Biro et al. 2009.
55 Tišljar 2004, str. 129, 215.
56 Ivanović et al. 1976.
57 Prominski konglomerati rasprostranjeni su u Ravnim kotarima, Dalmatinskoj zagori i u zapadnoj Hercegovini. Treba upozoriti na raznovrsnost strukture konglomerata iste i različite geološke starosti, osobito s arheološkog aspekta tehničke pogodnosti rožnjačkih valutičnih komponenti tih stijena. Stoga je terensko istraživanje s ciljem prikupljanja uzoraka za korelaciju s artefaktima neizostavno.
58 O lokalnim izvorima rožnjaka srednjopaleolitičkih artefakata u Ravnim kotarima, vidi u Vujević 2009.
59 Petrografsko određenje radiolaritnih valutica iz Neretve, Perhoč neobjavljeno istraživanje 2009. Radiolarit u Neretvu dospijeva vjerojatno u njenom gornjem toku iz zone bosanskog fliša, a jednim dijelom iz ladinika okolice Konjica, Jablanice i Drežnice (usmeno priopćenje dr. sc. Hazima Hrvatovića, Federalni geološki zavod BiH, 2011.).

55 Tišljar 2004, pp. 129 and 215.
56 Ivanović et al. 1976.
57 Promina conglomerates are widespread in Ravni Kotari, the Dalmatian highland interior (Zagora) and western Herzegovina. The diversity of the structure of conglomerates of the same or different geological ages must be underlined, particularly from the archaeological standpoint of technical suitability of the chert pebble components of these rocks. Field research for the purpose of gathering samples to correlate with artefacts is thus essential.
58 On local sources of the cherts in middle Palaeolithic artefacts in Ravni Kotari, see Vujević 2009.
59 On the petrographic specification of radiolarite pebbles from the Neretva, see Perhoč's unpublished research in 2009. Radiolarite gravel from the Neretva comes probably in its upper course from the Bosnian flysch zone and partly from Ladinian surrounding Konjic, Jablanica and Drežnica (personal communication with Hazim Hrvatović, Ph.D. Federal Geology Department of Bosnia-Herzegovina, 2011).
60 Šegota 1979, p. 32.

60 Šegota 1979, str. 32.
61 U zoni Budva najsjeverniji su izdanci mezozojskih (jura, donja i srednja kreda) dubokomorskih sedimenata s radiolaritima u vanjskim Dinaridima istočnog Jadrana. Zona Budva nastavlja se na jug preko zone Krasta-Cukali u Albaniji do zone Pindos-Olonos u Grčkoj. Facijalni razvoj zone Budva u tijesnoj je vezi s tektonikom susjedne platforme Visokog krasa što je rezultiralo izmjenom karbonatnih i kremičnih naslaga. Sedimenti zone Budva, nastali od trijasa do paleogena, predstavljeni su naslagama pješčenjaka, fliša, vulkansko-sedimentnih stijena, silicificiranih vapnenaca, vapnenaca s nodularnim i prugastim rožnjacima, radiolarita, šejlova i vapnenaca (Goričan 1994, str. 8-11).
62 Ofioliti su zajednica intruzivnih i efuzivnih stijena te silicijskih i klastičnih sedimenata koji se na našem interesnom području protežu od Banovine preko Bosne u pravcu Makedonije, a pripadaju europskom ofiolitnom kompleksu (Tišljar 2004, str. 219; Pamić, Hrvatović 2000, str. 60). Radiolariti koji su petrogenetski povezani s ofiolitima, na europskom prostoru se tijekom srednjeg trijasa, u razdoblju od srednje do gornje jure i donje krede sedimentiraju u eugeosinklinali Thetisa, a pojavljuju se u jurskim Alpama, sjevernim europskim područjima (Šumava, Türinger Wald, Harz, Norveška i Škotska) i južnim, od Sredozemlja preko Karpata te dalje prema Srednjem istoku (Grunau 1965, str. 157, 191).
63 Krivaja-Konjuh ofiolitni kompleks predstavlja najveći dio Dinarske ofiolitne zone jurske starosti s gornjotrijaskim olistolitima. Osim Krivaje-Konjuh, središnji dinarski ofiolitni pojas čine masivi Banija, Kozara, Vrbanja-Čelinac-Skatavica-Šnjegotinja, Ljubić-Čavka, Bosanski Ozren, Boja, Vardar-Tara-Zlatibor i Sjenički Ozren (Lugović et al. 1991, str. 202).
64 Kompleks Krivaja-Konjuh čine stijenska tijela gabra, diabaz-bazalta, amfibolita i ofiolitnog melangea. Ofiolitni melange čine fragmenti radiolarita, grauvake, bazalta, tufa, dijabaza, gabra, serpentiniziranog peridotita i egzotičnog vapnenca (Pamić, Hrvatović 2000, str. 60, 61).

61 The Budva zone has the northernmost outcrops of Mesozoic (Jurassic, lower and middle Cretaceous) deep-sea sediments with radiolarites in the external Dinaric Alps of the Eastern Adriatic seaboard. The Budva zone continues southward through the Krasta-Cukali zone into Albania up to the Pindos-Olonos zone in Greece. The facial development of the Budva zone is intimately tied to the tectonics of the neighbouring High Karst Plateau which resulted from an exchange of carbonate and silicon deposits. The sediments of the Budva zone, created from the Triassic to the Palaeogene, are represented by deposits of sandstone, flysch, igneous-sedimentary rock, silicified limestone, limestone, limestone with nodular and striped cherts, radiolarites, shales and limestones (Goričan 1994, pp. 8-11).
62 Ophiolites are a community of intrusive and effusive rocks and silicate and clastic sediments which extend in the area of interest relevant to this work from Banovina though Bosnia toward Macedonia, and they belong to the European ophiolite complex (Tišljar 2004, p. 219; Pamić, Hrvatović 2000, p. 60). Radiolarites petrogenetically tied to ophiolites sedimented in Europe during the mid-Triassic, mid- to late Jurassic and lower Cretaceous in the eugeosynclinal of Thetis, and they appear in the Jurassic Alps, northern (Šumava, Türinger Wald, Harz, Norway and Scotland) and southern Europe, from the Mediterranean through the Carpathians and onward to the Middle East (Grunau 1965, pp. 157, 191).
63 The Krivaja-Konjuh ophiolite complex constitutes the largest portion of the Dinaric ophiolite zone of Jurassic age with upper Triassic olistoliths. Besides Krivaja-Konjuh, the central Dinaric ophiolite belt consists of the Banija, Kozara, Vrbanja-Čelinac-Skatavica-Šnjegotinja, Ljubić-Čavka, Bosanski Ozren, Boja, Vardar-Tara-Zlatibor and Sjenički Ozren massifs (Lugović et al. 1991, p. 202.)
64 The Krivaja-Konjuh complex consists of rock bodies of gabbro, diabase-basalt, amphibolite and ophiolite mélange. Ophiolite mélange consists of fragments of radiolarite, greywacke, basalt, tufa, diabase, gabbro, serpentinized peridotite and exotic limestone (Pamić, Hrvatović 2000, pp. 60, 61).

dinaridne ofiolitne zone, u zajednici s vulkanskim stijenama i fragmentima uključenim u ofiolitski melange te graniči s bosanskim flišom. U nekim područjima bosanskoga fliša debljina sekvence proslojaka radiolarita, šejla i mikrita iznosi do 10 metara. Osim radiolarit formacije na području kompleksa Krivaja-Konjuh unutar središnjeg pojasa dinaridskog ofiolita, u istočnom pojasu su radiolariti kartirani u paleozojsko-trijaskoj formaciji zone Golija. Radiolariti s područja kompleksa Krivaja-Konjuh uglavnom su crvene boje (Pamić navodi inačicu *jaspis*), preslojavaju se sa šejlom, rijetko s mikritom, a u nekim područjima se radiolariti ravnomjerno izmjenjuju s mikritima. Radiolarit formacija se stratigrafski proteže od kasnog trijasa do krede.[65] Fragmenti radiolaritnih stijena iz primarnih ležišta ofiolitnog melangea i radiolarit formacije, erozivnim procesima dospijevaju u bosanske rijeke i tijekom transporta zaobljuju se u valutice i oblutke.[66]

Osim kopačinskih, crvene (zelene i crne) radiolaritne artefakte, kako alatke tako i tehnološki ostatak, ustanovili smo u istodobnom inventaru Vele spile, a predmnijevamo ga i u inventaru Badnja.[67] Navedene hipoteze o mogućim i vjerojatnim izvorima radiolarita korištenih u proizvodnji kopačinskih artefakata, treba potvrditi daljnjim geoarheološkim terenskim istraživanjem izdanaka radiolarita kao i laboratorijskim uspoređivanjem artefakata i petrografskih uzoraka tih stijena.[68]

7.2. Skupina zelenih radiolarita

Samo 1,45 % težine analizirane litike čine artefakti izrađeni od kamena zelene boje, odnosno 99 nalaza ili 2,15 % od ukupnog broja, ipak značajnih za problematiku provenijencije sirovine (sl. 9) jer su petrografski, izuzevši boju i odsutnost okorine, srodnici crvenih radiolarita.

65 Radiolarite čine brojne radiolarije sastavljene od kalcedona i opala s malim primjesama kalcita, sitnih zrnaca hematita i organske tvari. Mikriti su kalcitični ili su silicificirani. Šejlove izgrađuju minerali gline, kvarc, feldšpat i hematit u crvenim varijetetima, a organska materija u tamnosivim (Pamić 2000, str. 70).

66 Prema Pamić, Hrvatović 2000, str. 67; Pamić 2000, str. 70 i osobnom priopćenju dr. Hazima Hrvatovića (Federalni geološki zavod BiH, Sarajevo 2010). Perhoč, nobjavljeno istraživanje.

67 Crvene radiolaritne artefakte za sada smo zabilježili još u litičkim inventarima prapovijesnih nalazišta na otocima Veloj Palagruži i Sušcu te u pećini Vlakno na Dugom otoku i drugim nalazištima na prostoru Hrvatske, u pećini Zala u Gorskom kotaru, Vindiji, Ozalj-gradu, Bapskoj (Perhoč, neobjavljena istraživanja). Zahvaljujemo arheolozima dr. sc. Marcelu Buriću, mr. sc. Borisu Čargu, dr. sc. Staši Forenbaheru, dr. sc. Branku Kiriginu, Mati Parici, Dinku Radiću, Branki Stergar, Marini Šimek i dr. sc. Dariju Vujeviću, što su nam omogućili pregled inventara navedenih nalazišta.

68 Analogno nalazu minerala krom-spinela (akcesorni mineral ofiolitnih stijena) u artefaktu od crvenog radiolarita iz Vele spile s Korčule, takve artefakte možda je moguće korelirati s bosanskim ofiolitskim izvorima ili njima bliskima. Na vezu krom-spinela i ofiolitskih stijena upozorio nas je geolog Professor Rainer Altherr, Institut für Geowissenschaften, Rupprecht-Karls-Universität Heidelberg, 2009 (usp. Majer, Jurković 2001, str. 337).

the Bosnian flysch, the thickness of the sequence of radiolarite, shale and micrite interlayers reaches up to 10 m. Besides the radiolarite formation in the territory of the Krivaja-Konjuh complex inside the central belt of the Dinaric ophiolite, radiolarites have been mapped in the Palaeozoic-Triassic formation of the Golija zone in the eastern belt. Radiolarites from the Krivaja-Konjuh complex are generally red (Pamić uses the variant *jaspis*), they overlay with shale, and more rarely with micrite, although in some regions there is uniform alteration between radiolarites and micrites. The radiolarite formation stratigraphically extends from the late Triassic to the Cretaceous.[65] Fragments of radiolarite rock from the primary deposits of the ophiolite mélange and the radiolarite formation reached Bosnian rivers by means of erosive processes and assumed the form of pebbles and cobbles during conveyance.[66]

Besides the Kopačina red (green and black) radiolarite artefacts, both tools and technological remainders, we have ascertained a coterminous inventory in Vela Spila, and we have also assumed its existence in the inventory of Badanj.[67] This hypothesis on possible and probable sources of the radiolarites in the production of the Kopačina artefacts should be confirmed by further geoarchaeological field research into radiolarite outcrops and in laboratory comparisons of artefacts and petrographic samples from these rocks.[68]

7.2. Group of green radiolarites

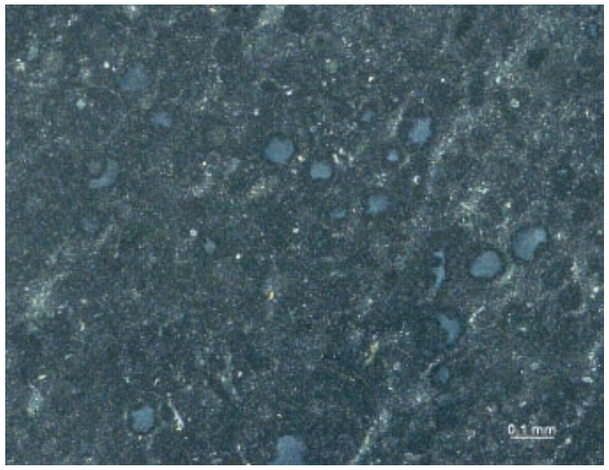
Only 1.45% of the weight of the analyzed lithics consists of artefacts made of green-coloured stones, or 99 finds or 2.15% of the total number, which is nonetheless significant to the problem surrounding the origin of the raw materials (Fig. 9) because petrographically - excepting the colour and absence of cortex - they are akin to red radiolarites.

65 Radiolarites consist of numerous radiolaria composed of chalcedony and opal with tiny admixtures of calcite, fine grains of haematite and organic substances. Micrites are calcitic or silicified. Shales are composed of minerals of clay, quartz, feldspar and haematite in red varieties, and organic matter in dark grey (Pamić 2000, p. 70).

66 Based on Pamić, Hrvatović 2000, p. 67; Pamić 2000, p. 70 and personal communication Hazim Hrvatović, Ph.D. (Federal Geology Department of Bosnia-Herzegovina, Sarajevo), 2010. Perhoč, unpublished research.

67 For now, we also have recorded red radiolarite artefacts in the lithics inventories of prehistoric sites on the islands of Vela Palagruža and Sušac and Vlakno Cave on the island of Dugi and other sites in Croatia, in Zala Cave in Gorski Kotar, Vindija, Ozalj-grad, and Bapska (Perhoč, unpublished research). We would like to thank archaeologists Marcel Burić, Ph.D., Boris Čargo, Ph.D., Stašo Forenbaher, Ph.D., Branko Kirigin, Ph.D., Mate Parica, Dinko Radić, Branka Stergar, Marina Šimek and Dario Vujević, Ph.D. for allowing us to examine the inventory of these sites.

68 By way of analogy to the discovery of chrome-spinel (an accessory mineral of ophiolite rocks) in a red radiolarite artefact from Vela Spila on Korčula, such artefacts may be correlated with Bosnian ophiolite and similar sources. The link between chrome-spinel and ophiolite rocks was pointed out to us by geologist Professor Rainer Altherr, Ph.D., Institut für Geowissenschaften, Rupprecht-Karls-Universität Heidelberg, 2009 (cf. Majer, Jurković 2001, p. 337).



Slika 13.
Zeleni radiolarit. Polarizacijski mikroskop, polarizirano svjetlo

Figure 13.
Green radiolarite. Polarized light microscope, polarized light

Kamen artefakata rožnata izgleda iz ove skupine je zelen, sivozelenkast,[69] oštrog konkavno-konveksnog loma, voštanog sjaja i slabe do srednje svjetlopropusnosti na tankim rubovima, homogen, gust, izrazito žilav i tvrd.[70] Na nabrusku su u matriksu vidljiva rijetka, vrlo sitna žuta i crvena zrna, vjerojatno hematita. U izbrusku pod polarizacijskim mikroskopom s ukriženim nikolima ustanovili smo za kremene stijene uobičajenu mikro do kriptokristalnu mozaičnu strukturu matriksa s gnijezdima vlaknastog kalcedona u radijalnom ili sferulitičnom rastu. U prolaznom svjetlu se vidi kako radiolarije naliježu jedna na drugu (sl. 13).[71] Radiolarije su u ovom kamenu makroskopski teško uočljive.

Zanimljivo je da u zelenoj skupini gotovo da nema nalaza s jednoznačno odredivom valutičnom okorinom. Tek na dva primjera smo zapazili okorinu, ali tako male površine da nije moguće odrediti radi li se o valutičnoj okorini ili o međuslojnoj površini.[72] Stoga, zasad ostaje nejasno je li sirovina za artefakte od zelenog radiolarita brana iz autohtonih ili alohtonih izdanaka. Zeleni (i crni) radiolariti odlične kakvoće kakvih ima u ofiolitima

69 10GY5/2.

70 Prema osobnom priopćenju Ilone Fin, Radionica za izradu mikroskopskih preparata, Institut für Geowissenschaften, Universität Heidelberg 2010.

71 Zahvaljujemo geolozima dr. sc. Jožici Zupanič i dr. sc. Draženu Kurtanjeku, PMF u Zagrebu, koji su nam pomogli u rješavanju ove petrografske dvojbe.

72 Međuslojnom površinom ovdje označavamo dio stijene kojom ona prianja na drugu iste ili drugačije petrografije i koja je izložena trošenju pa se izgledom razlikuje od ostalog dijela stijene. Na malim uzorcima, kakvi su najčešće litički artefakti, međuslojnu površinu nije uvijek moguće razlikovati od pukotine.

The stone in the artefacts with cherty appearance from this group is green or grey-green,[69] with sharp concave and convex fraction, waxy lustre and weak to medium translucence at the thin edges, homogenous, dense, quite tough and hard.[70] Rare, very tiny yellow and red grains, probably haematite, are visible in the matrix in thin-sections. In thin-sections under a polarized light microscope with crossed Nicols, we have ascertained flint stone with the customary micro- to crypto-crystalline mosaic structure of the matrix and bundles of fibrous chalcedony in radial or spherulitic growth. In plane-polarised light, the radiolaria overlaying one another are visible (Fig. 13).[71] Radiolaria in this stone are difficult to observe macroscopically.

It is interesting that in the green group there are almost no finds with an unambiguously determinate rind of pebbles. A rind was only observed on two examples, but on such a small surface that it was not possible to determine whether this was a rind of pebbles or a surface interlayers.[72] Thus, for now it remains unclear as to whether the raw materials for the green radiolarite artefacts were gathered from autochthonous or allochthonous outcrops. Green (and black) radiolarites of excellent quality as among the ophiolites of Banija with the outcrop at Lasinja,[73] macroscopically correspond entirely with the Kopačina finds, so this indicates possible sources of raw materials in the belt of Dinaric ophiolite and Bosnian flysch.[74]

Only two green radiolarite finds appear alongside the red examples. One has a laminary structure, with sharply divided colours, while the other, on which a rind of pebbles with impact marks has been preserved, has overlapping green and red. We have classified them in the red radiolarite group. It should be noted that the red or green colour of radiolarites depends on the di- and trivalent iron which pigments primarily transparent mineral quartz or chalcedony, and that multi-coloured radiolarite rocks in the same outcrop are not rare. How much the colour of the rocks in these artefacts may contribute to determining the origin of their sources will be shown

69 10GY5/2.

70 According to personal communication from Ilona Fin, Microscopic Solution Workshop, Institut für Geowissenschaften, Universität Heidelberg 2010.

71 We would like to thank geologists Jožica Zupanič, Ph.D. and Dražen Kurtanjek, Ph.D., Faculty of Science and Mathematics, Zagreb, who helped us resolve this petrographic dilemma.

72 Here the surface of interlayers designates the part of the rock where it contacts another of the same or different petrography and which is exposed to wear, so its appearance differs from the remaining parts of the rock. On small samples, which lithic artefacts usually are, the surface of interlayers cannot always be distinguished from a fissure.

73 We would like to thank Rajna Šošić Klindžić, Ph.D. (Faculty of Humanities and Social Sciences, Zagreb) and Josip Halamić, Ph.D. (Croatian Geology Institute, Zagreb) for samples of green and black radiolarite from Banovina. On radiolarites of Jurassic-Triassic age in the highlands of Žumberak, Medvednica, Ivanščica and Kalnik, as well as the archeologically relevant green and black radiolarites in Banovina (Lasinja, Zrinska gora), see Halamić and Šošić Klindžić 2009.

74 Hrvatović 2006, and also based on personal communication from Hazim Hrvatović, Ph.D. (Federal Geology Department of Bosnia-Herzegovina, Sarajevo) 2010.

Banije s izdankom kod Lasinje,[73] makroskopski sasvim odgovaraju kopačinskim nalazima pa nas to upućuje na moguće izvore sirovine u pojasu dinaridskih ofiolita i bosanskoga fliša.[74]

Samo se na dva radiolaritna nalaza zelena boja pojavljuje uz crvenu. Jedan je laminarne strukture, oštro odvojenih boja dok se na drugom, na kojem je sačuvana valutična okorina s udarnim napuklinama, zelena i crvena boja prelijevaju. Svrstali smo ih u skupinu crvenih radiolarita. Treba upozoriti da crvena ili zelena boja radiolarita ovisi o odnosu dvovalentnog i trovalentnog željeza koje pigmentira primarno proziran mineral kvarc ili kalcedon i da nije rijetka višebojna radiolaritna stijena na istom izdanku. Koliko boja predmetne stijene artefakata ipak može pridonijeti određenju porijekla njezinog izvora, pokazat će terensko istraživanje konkretnih autohtonih i alohtonih izdanaka dotičnih stijena i njihovo mikrofacijelno ispitivanje. Ova dva nalaza ne dopuštaju zaključak o zajedničkom porijeklu sirovine za artefakte iz zelene i crvene radiolaritne skupine.

7.3. Skupina metasomatskih nodularnih rožnjaka

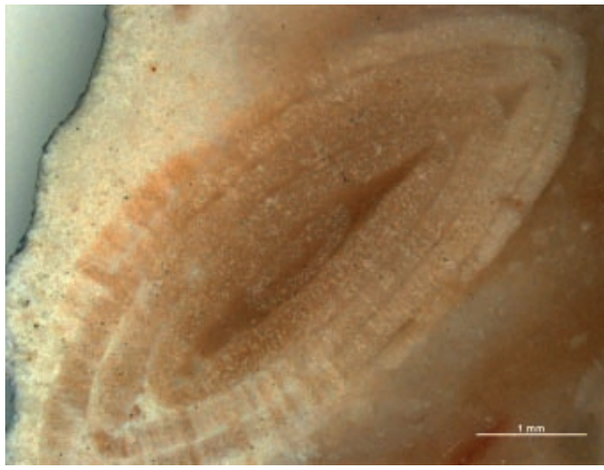
Litološki gledano, Brač i Dalmacija sastavni su dio karbonatne platforme dinarskoga krša izgrađenog od karbonatnih stijena kontinuirano taloženih od trijasa do paleogena.[75] Izdanci rožnjaka koji se pojavljuju s tim stijenama rasuti po cijeloj regiji, jesu trijaske, jurske, kredne, najčešće paleogenske starosti. Stoga ne čudi da je većinski dio arheološkog litičkog inventara istraženih prapovijesnih kamenodobnih nalazišta u regiji i šire, pa i kopačinski, izrađen upravo od metasomatskih rožnjaka nastalih i dostupnih u karbonatnim stijenama Dinarida.

Nodularni metasomatski ili zamjenski rožnjaci nastaju u ranodijagenetskom procesu silicifikacije stijene domaćina (najčešće vapnenaca, ali i dolomita, lapora) pri čemu mineral kvarca (opal, kalcedon, mikrokristalni i kriptokristalni kvarc) zamjenjuje karbonatni talog (mineral kalcit), njegove primarne i sekundarne komponente.[76] Rožnjaci pritom preuzimaju strukturu stijene na mjestu nastanka pa ih je po tome moguće razlikovati unutar varijeteta, ovisno o stupnju sačuvanosti te strukture.[77] Pojavljuju se kao pojedinačne nodularne nakupine, skupine nodula u nizu ili izdužene lećaste forme paralelne slojevima stijene domaćina, a slojeviti ili prugasti rožnjaci kao samostalni slojevi. Zahvaljujući genetskim reliktima stijene domaćina u rožnjacima, rožnjake upotrijebljene za izradu artefakata donekle je moguće korelirati s vjerojatnim ležištima tih stijena. U kopačinskom inventaru izdvojili smo sljedeće podskupine artefakata zgotovljenih od metasomatskih rožnjaka: numulitni, mikritni, bioklastični i crni rožnjaci.[78]

7.3.1. Numulitni rožnjaci

Sa 256 nalaza (5,56 % od ukupnog broja) težinski udio ove podskupine iznosi 8,03 % (sl. 9). Nalazi od numulitnih rožnjaka su žućkastosmeđih tonova,[79] voštanog sjaja i slabe svjetlopropusnosti na tanjim rubovima. Nodularne jezgre su sivobijele, češće žućkastosmeđe, a okorina zna biti dodatno patinirana crvenicom. Brojne kalcitne partije i uklopljeni biodetritus smanjuju homogenost i tvrdoću kamena pa lom nije izrazito konhoidalan, nego facetiran.[80] Foraminifere numuliti dominiraju među fosilima, često su vidljive prostim okom (najveća izmjerena je duljine 13 mm). Isti fosili pojavljuju se u okorini kao i u jezgri nodule i to je školski primjer dijagenetskog postanka rožnjaka ovoga tipa (sl. 14).

Nodularna okorina na brojnim nalazima dodatno potvrđuje da se radi o metasomatskom rožnjaku. Na staništu su nađeni krupniji fragmenti nodula od kojih su preparirane tehnološke jezgre. Okorina je trošna i kavernasta na mjestu ispranih kalcitnih faza, ali bez tragova habanja, što govori da su nodule brane na paraautohtonom izdanku ili su stršeće nodule lomljene iz stijene domaćina. Pored fosilnog detritusa neodredive pripadnosti, u kvarcnom matriksu vidljive su staklaste ljušturice protozoa numulita (sl. 14), po čemu porijeklo ove podskupine treba tražiti u eocenskim vapnencima. Od foraminifera zapažene su još diskocikline, globigerine, alveoline (orbitolide), a od ostalih fosila bodlje brahiopoda, peteljke zelenih algi (dasikladacea) i ehinoderme.



Slika 14.
Numulitni rožnjak. Binokularni mikroskop, nabrusak

Figure 14.
Nummulitic chert. Binocular microscope, polished section

by field research into specific autochthonous and allochthonous outcrops of these rocks and their microfacial testing. These two finds do not allow for a conclusion on the common origin of the raw materials for artefacts from the green and red radiolarite group.

7.3. Group of metasomatic nodular cherts

Considered in lithological terms, Brač and Dalmatia are a component of the carbonate platform of the Dinaric karst composed of carbonate rock that was deposited continually from the Triassic to the Palaeogene.[75] Chert outcrops which appear with these rocks scattered throughout the entire region are of Triassic, Jurassic, Cretaceous, and most often Palaeogenic age. Therefore it is not surprising that most of the archaeological lithics inventory of the prehistoric Stone Age sites in the region and beyond, including the Kopačina Cave, consists precisely of metasomatic cherts that emerged and became available in the carbonate rocks of the Dinaric zone.

Nodular metasomatic or diagenetic cherts emerge in the early diagenetic process of silicification of the host rock (most often limestones, but also dolomite, marl) wherein quartz minerals (opal, chalcedony, micro- and crypto-crystalline quartz) replace the carbonate sediment (mineral calcite), its primary and secondary components.[76] Cherts here assume the structure of the rock at the point of origin, so they can thereby be distinguished within varieties, depending on the degree of preservation of this structure.[77] They appear as individual nodular accretions, nodule groups in a row or as elongated lentil-shaped forms parallel to the layers of the host rock, while layered or striped cherts appear as independent layers. Thanks to the genetic relics of the host rock in them, the cherts used to make artefacts can to a certain extent be correlated with the possible deposits of these rocks. In the Kopačina inventory, we have distinguished the following sub-groups of artefacts finished from metasomatic cherts: nummulitic, micritic, bioclastic and black cherts.[78]

7.3.1. Nummulitic cherts

With 256 finds (5.56% of the total number), the weight share of this sub-group is 8.03% (Fig. 9). Finds made of nummulitic cherts have yellowish-brown tones[79] with waxy lustre and poor translucence at the thinner edges. The nodular cores are grey-white, often yellow-brown, while the cortex may be patinated red. Numerous calcite sequences and incorporated biodetritus reduce the homogeneity and hardness of the stone, so the fraction is not markedly conchoidal, but rather faceted.[80] Foraminiferous nummulites dominate among the fossils, and are often visible to the naked eye (longest measured length is 13 mm). The same fossils appear in the cortex and in the nodule core, and this is a textbook example of diagenetic formation of cherts of this type (Fig. 14).

The nodular rim on many finds further confirms that this is metasomatic chert. Larger nodule fragments were found in the habitat that were used to make technological cores. The cortex is worn and pitted at the place of the eroded calcite phase, but without traces of wear, which indicates that the nodules were gathered at a para-autochthonous outcrop or that jutting nodules were broken off from the host rock. Besides fossil detritus of indeterminate character, glassy nummulitic protozoa shells (Fig. 14) are also visible in the quartz matrix, so that the origin of this sub-group should be sought in the Eocene limestones. Among the foraminifers, discocyclinae, globigerinae, and alveolinae (orbitolidae) have also been observed, while among the remaining fossils, the spines of brachiopods, the stalks of green algae (dasycladales) and echinoderms have been noted.

73 Zahvaljujemo dr. sc. Rajni Šošić Klindžić (Filozofski fakultet u Zagrebu) i dr. sc. Josip Halamiću (Hrvatski geološki institut, Zagreb) na uzorcima zelenih i crnih radiolarita iz Banovine. O radiolaritima jursko-trijaske starosti na Žumberku, Medvednici, Ivanščici i Kalniku, kao i arheološki relevantnim zelenim i crnim radiolaritima na Banovini (Lasinja, Zrinska gora), vidi u Halamić, Šošić Klindžić 2009.

74 Hrvatović 2006 i prema osobnom priopćenju dr. sc. Hazima Hrvatovića (Federalni geološki zavod BiH, Sarajevo, 2010).

75 Geografski pojednostavnjeno, pojas dinarskog krša proteže se u regijama uz more i duboko u zaleđu duž cijelog istočnog Jadrana (Tišljar et al. 2002, str. 139-141).

76 Klasifikacija vapnenaca provodi se prema strukturno-teksturnim značajkama koje su odraz ekoloških, sedimentoloških i hidrodinamičkih uvjeta i okoliša taloženja. Paleontološko imenovanje vapnenaca slijedi prema prevladavajućoj vrsti fosila, a sedimentološko i petrografsko prema genetskim značajkama stijene (Füchtbauer, Müller 1970, str. 494; Tišljar 2001, str. 221). Geneza metasomatskih rožnjaka neodvojiva je od geneze karbonatnih stijena u kojima oni nastaju, zahvaljujući čemu je moguće odrediti i imenovati tipove rožnjaka (usp. Affolter 2002).

75 Geographically simplified, the Dinaric karst belt extends from regions along the coast deep into the hinterland of the entire Eastern Adriatic seaboard (Tišljar et al. 2002, pp. 139-141).

76 Classification of limestone is done according to structural-textural features which are a reflection of ecological, sedimentological and hydrodynamic conditions and the sedimentation environment. The palaeontological designation of limestones is based on the predominant fossil type, while sedimentologically and petrographically according to the genetic features of the rock (Fürchtbauer, Müller 1970, p. 494; Tišljar 2001, p. 221). The genesis of metasomatic cherts is inseparable from the genesis of the carbonate rocks in which they form, thanks to which it is possible to designate chert types (cf. Affolter 2002).

77 Tišljar 2001, str. 46.

78 Unatoč nekoliko desetaka autohtonih izdanaka rožnjaka i srodnih stijena koje smo do sada registrirali u užem i širem krugu radnog prostora, vjerujemo da se nismo približili metodički kritičnom broju uzoraka predmetnih stijena neophodnom za sustavnu mikrofacijalnu analizu i korelaciju s kamenim artefaktima temeljem pojedinih petrografskih tipova (Perhoč 2009b).

79 5YR 5/2, 10 YR 6/2.

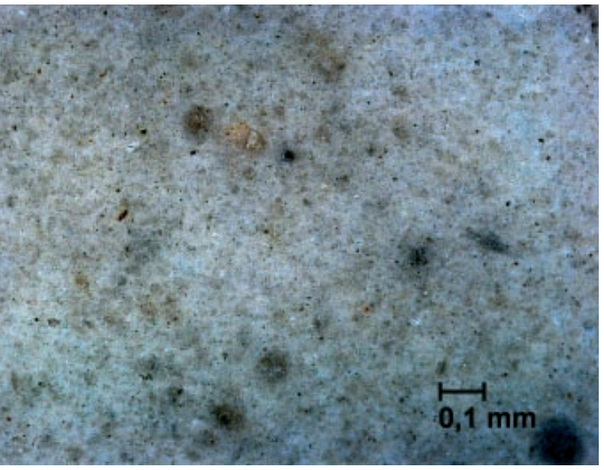
80 Tehnička vrsnoća rožnjaka može se prepoznati po tvrdoći, izraženom konhoidalnom lomu, glatkoj plohi loma i oštrom bridu.

77 Tišljar 2001, p. 46.

78 Despite several dozen autochthonous outcrops of chert and related rocks which we have thus far been registered in the narrower and wider radius of the work area, we believe that we have not approached the methodologically critical number of samples of the relevant rocks necessary for systematic microfacial analysis and correlation with stone artefacts based on individual petrographic types (Perhoč 2009b).

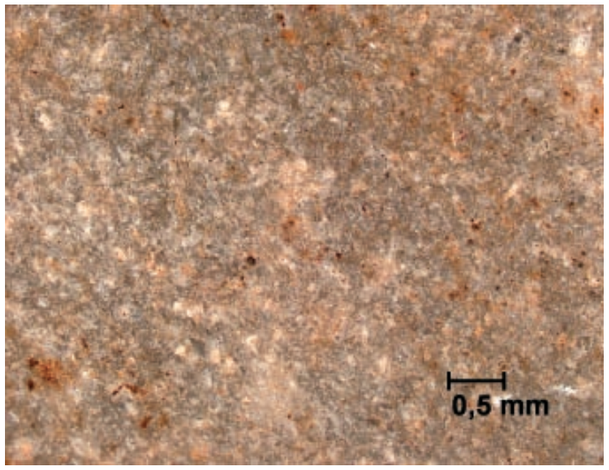
79 5YR 5/2, 10 YR 6/2.

80 The technical excellence of cherts may be recognized in their hardness, expressed as conchoidal fraction, the smooth surface and the sharp edge.



Slika 15.
Mikritni rožnjak. Binokularni mikroskop, nabrusak

Figure 15.
Micritic chert. Binocular microscope, polished section



Slika 16.
Bioklastični rožnjak. Binokularni mikroskop, nabrusak

Figure 16.
Bioclastic chert. Binocular microscope, polished section

Numulitni rožnjaci vjerojatno su otočki import, jer su eocenske naslage vapnenaca na Braču neznatne i bez rožnjaka.[81] Od ostalih srednjodalmatinskih otoka, u uskom hvarskom eocenskom pojasu otkrili smo tek tragove rožnjaka bez ikakve tehničke vrijednosti.[82] Brojne, obilne i lako dostupne, Braču najbliže izdanke eocenskih rožnjaka zabilježili smo u srednjodalmatinskom eocenskom pojasu splitsko-kaštelanskog područja,[83] i to na južnoj padini brda Vlaška, u Segetu Donjem, na Oporu, Kozjaku i Mosoru, na poluotoku Marjanu, na Čiovu i u Baškoj Vodi.[84]

7.3.2. Rožnjaci mikritnog vapnenca

Artefaktima najzastupljenija podskupina rožnjaka nastalog u mikritnom vapnencu, u kojoj razlikujemo tip sivog neprozirnog i tip žućkastog svjetlopropusnog rožnjaka je otočkog porijekla. Podskupina broji 1774 nalaza (38,56 % od ukupnog broja) i težinskog je udjela od 42,79 % u ukupnoj masi inventara (sl. 9). Brački rožnjaci, naročito sivi tip, tehničkom kakvoćom osjetno zaostaju za kakvoćom kamena iz drugih skupina, mahom iz udaljenijih izvora.

Sivi tip sa 1077 nalaza prevladava u ovoj podskupini. Jezgreni dio nodule je siv, s nekoliko nijansi, vrlo neizraženog sjaja ili sasvim mat i slabe svjetlopropusnosti, najčešće svjetlonepropustan.[85] Rožnjak je nastao u mrvičastom mikritnom vapnencu (sl. 15).

81 Tumač osnovne geološke karte u bračkim eocenskim naslagama kod rta Gomilice ne navodi pojavu rožnjaka (Magaš, Marinčić 1973, str. 23; Marinčić et al. 1971).
82 Marjanac et al. 1998, str. 224. Rožnjake u eocenskom pojasu na poluotoku Pelješcu nismo istraživali.
83 Marjanac 1987, str. 182-188; Marjanac et al. 1998, str. 224.
84 Podrobnosti o izdancima, vidi u Perhoč 2009b.
85 N9-4; u nabrusku su vidljiva crvena i žuta sitna zrna hematita i getita.

The nummulitic cherts are probably an island import, because the Eocene limestone deposits on Brač are negligible and do not contain cherts.[81] On the remaining central Dalmatian islands, we have only discovered vestiges of cherts without any sign of technological value in the narrow Hvar Eocene belt.[82] The most numerous, abundant and easily accessible outcrops of Eocene chert closest to Brač were recorded in the central Dalmatian belt of the Split-Kaštel area[83] on the southern slope of Vlaška Hill, in Seget Donji, on Opor, Kozjak and Mosor, on the Marjan Peninsula, on the island of Čiovo and in Baška Voda.[84]

7.3.2. Micritic limestone cherts

The sub-group of cherts which emerged in micritic limestone, wherein the grey transparent type is distinguished from the yellowish translucent chert, and which encompasses the most artefacts, is of insular origin. The sub-group contains 1,774 finds (38.56% of the total number) and its weight share is 42.79% in the total inventory mass (Fig. 9). The Brač cherts, particularly the grey type, evidently lags behind the quality of the stones from other groups, largely from more distant sources.

The grey type, with 1,077 finds, predominates in this sub-group. The core portion of the nodule is grey with several nuances, with very unremarkable lustre or even entirely matte and poor translucence, most often opaque.[85] The chert emerged in friable micrite limestone (Fig. 15).

81 The guide to the basic geological map does not indicate the appearance of cherts in the Brač Eocene deposits at Cape Gomilica (Magaš, Marinčić 1973, p. 23; Marinčić et al. 1971).
82 Marjanac et al. 1998, p. 224. We did not research the cherts in the Eocene belt on Pelješac Peninsula.
83 Marjanac 1987, pp. 182-188; Marjanac et al. 1998, p. 224.
84 For details on outcrops, see Perhoč 2009b.
85 N9-4; red and yellow tiny grains of haematite and goethite are visible in the polished section.

Fosilni detritus na nabrusku nije vidljiv. Do sada smo ovakve rožnjake na Braču zabilježili na sjevernoj strani otoka u gornjokrednoj zoni vapnenaca s lećama, uloščima ili proslojcima dolomita. U Pučišćima na brdu Mala Bračuta i sjevernoj padini Mladinjeg brda zabilježen je autohtoni izdanak rijetkih leća rožnjaka. Izdanak rožnjaka u okolici Dola je izdašniji, nešto je bolje kakvoće i time arheološki relevantniji. Rijetkih fragmenata nodula ima u nanosu bujičnjaka u polju Dunaj, više u siparu okolnih brda, osobito na sjevernom i zapadnom obronku Velog brda, gdje su vidljivi izdanci vapnenca s rožnjacima.

Žućkasti, žutosmeđi tip ima voštani sjaj i izraženiju transparentnost u odnosu na sivi tip.[86] U nabrusku je u mikritnoj masi vidljiv vrlo sitan fosilni detritus. Rožnjak žućkastog tipa bolje je kakvoće od sivih, ali i među sivima ima crnosivih partija, obično prema središtu nodule, koje su bolje kakvoće od perifernih dijelova. Nodularna okorina ima iste tragove trošenja kao i u skupini fosilifernih rožnjaka, što upućuje na isti tip izdanka. Porijeklo žućkastog tipa rožnjaka temeljem slične strukture vežemo za sivi tip, no konkretna ležišta nam nisu poznata. U oba tipa ove podskupine ima primjeraka sa zonarnom strukturom.

Geološki podaci o formaciji Sveti Duh s vapnencima i dolomitima turonske gornjokredne starosti u kojima ima kvrga rožnjaka na području između Vidove gore i Gornjeg Humca,[87] kao i naši nalazi rožnjačkog krša na žalu bolskog zaljeva, ukazuju da na Braču ima više ležišta rožnjaka nego što smo ih do sada zabilježili.[88]

7.3.3. Rožnjaci bioklastičnog vapnenca

Težinski udio ovog rožnjaka je 15,97 %, sa 483 nalaza zauzima 10,5 % od ukupnog broja (sl. 9). Rožnjaci su zagasite smeđe boje, voštanoga sjaja i slabe ili nikakve svjetlopropusnosti.[89] Nodularna okorina, po kojoj ih svrstavamo u metasomatske nodularne rožnjake, smeđe je boje kao i jezgra, ali svjetlija. Jezgreni dio nodule vrlo je ujednačene sitnozrne strukture koja pod povećalom ima ljuskav izgled. Na nabrusku je vidljivo da je rožnjak nastao silicificiranjem gustog mikrita i uglavnom neprepoznatljivih sitnih fragmenata ljušturica morskih organizama (razaznaju se ljušturice školjkaša i brahiopoda) (sl. 16). Vide se rijetka raspršena crvena zrnca hematita.

Gotovo trećina nalaza iz ove podskupine duboko je patinirana pa se vanjska trošna kora uvelike razlikuje od jezgrenog dijela. Trošnu koru karakteriziraju sitne kaverne nastale ispiranjem kalcita, a vidljive su tek pod povećalom. Ispunjene su crvenicom pa kamen djeluje zrnato, prigušenog je porculanskog sjaja ili je sasvim mat.

86 10YR5/4.
87 Derado 1984, str. 8, 9 (karta prema Nastiću et al. 1958).
88 Perhoč neobjavljeni nalaz 2010.
89 10YR4/2, 5/4.

Fossil detritus is not visible on the polished section. Thus far, we have recorded such cherts on Brač on the northern side of the island in the Upper Cretaceous zone of limestones with lenses, inserts or interlayers of dolomite. In Pučišće, on Mala Bračuta Hill and the northern slope of Mladinje Hill, an autochthonous outcrop of rare chert lenses were recorded. The chert outcrop in the vicinity of Dol is more productive, with somewhat higher quality product and thus more archeologically relevant. There are rare nodule fragments in the torrential detritus in Dunaj field, and more in the loose rock of the surrounding hills, particularly on the northern and western slope of Veli Hill, where outcrops of limestone with cherts are visible.

The yellowish, yellow-brown type has a waxy lustre and more notable transparency than the grey type.[86] Very tiny fossil detritus is visible in the micritic mass in the polished section. The yellowish chert type is of a better quality than the grey, but among the greys there are black-grey lots, normally toward the middle of the nodule, which have a higher quality than the peripheral portions. The nodular rim has the same traces of wear as in the fossiliferous chert group, which indicates the same type of outcrop. We have linked the origin of the yellowish chert type to the grey type based on a similar structure, but we know of no specific deposit. There are examples of zonal structure in both types of this sub-group.

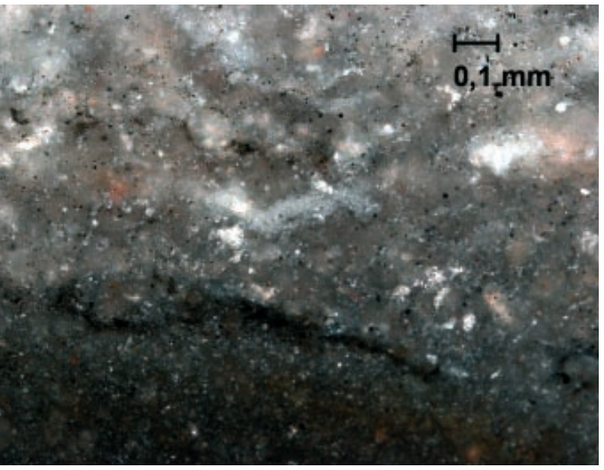
The geological data on the formation of Sveti Duh with limestones and dolomites of Turonian Upper Cretaceous age in which there are bulbs of chert in the area between Vidova gora and Gornji Humac,[87] just like our finds of chert karst on the beaches of the Bol inlet, indicate that there are more chert deposits on Brač than we have thus far recorded.[88]

7.3.3. Bioclastic limestone cherts

The weight share of this chert is 15.97%, with 483 finds, accounts for 10.5% of the total number (Fig. 9). The cherts are dark brown, with waxy lustre and poor or no translucence.[89] The nodular rim, whereby we have classified it in the metasomatic nodular cherts, is brown like the core, but lighter. The core portion of the nodule has a very uniform fine-grain structure which has a shell-like appearance under the magnifying scope. On a thin-section, it is apparent that the chert emerged by silicification of dense micrite and generally unrecognizable tiny fragments of shells of marine organisms (the shells of shellfish and brachiopods can be discerned) (Fig. 16). Rare, scattered red haematite grains can be seen.

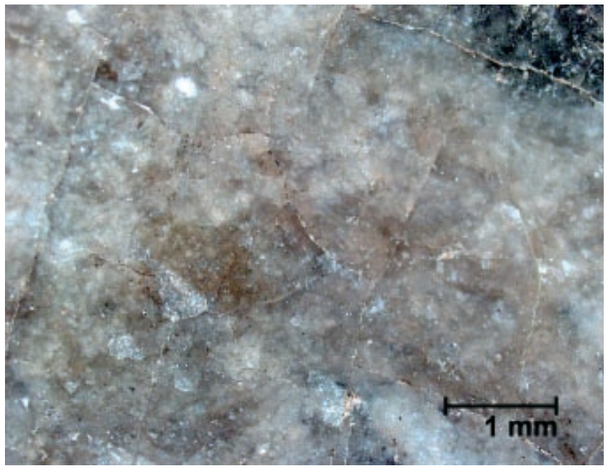
Almost of a third of the finds from this sub-group are deeply patinated, so the external worn cortex largely differs from the core portion. The wear cortex is characterized by tiny cavities made by the washing off of calcite, and only visible under a magnifying scope. They are filled with terra rossa, so the stone seems grainy, with a dark porcelain lustre, or entirely matte.

86 10YR5/4.
87 Derado 1984, pp. 8-9 (map based on V. Nastić et al. 1958).
88 Perhoč, unpublished find, 2010.
89 10YR4/2, 5/4.



Slika 17.
Crni rožnjak. Binokularni mikroskop, nabrusak

Figure 17.
Black chert. Binocular microscope, polished section



Slika 18.
Žareni rožnjak. Binokularni mikroskop, nabrusak

Figure 18.
Burned chert. Binocular microscope, polished section

Podrobnija karakterizacija bez destrukcije artefakata nije moguća. Pripadnost takvih nalaza ovoj podskupini moguće je ustanoviti tek temeljem nabruska, što znači da je postotak pogreške u makroskopskom klasificiranju bez mikrofacijelne kontrole viši negoli u drugim skupinama. Ovakav rožnjak je čest među metasomatskim rožnjacima; prema tipu vapnenca domaćina pretpostavljamo i dalmatinska ležišta koja za sada nismo pobliže locirali.[90]

7.3.4. Crni rožnjaci

Skupina crnog rožnjaka (sl. 9) broji 679 nalaza (14,76 % od ukupnog broja) s težinskim udjelom od 15,02 %. Kamen je voštanog staklastog sjaja, različitih stupnjeva svjetlopropusnosti, izraženog konhoidalnog loma, mjestimično facetiranih lomnih ploha, glatkih i oštrih bridova. Po sivocrnim i zelenkastim nijansama uvjetno bi se moglo govoriti o dva tipa.[91] Rožnjak je većinom metasomatskog postanka.[92] Na to ukazuju tzv. fosilni "duhovi", okruglaste ili nepravilne uglavnom svjetlije mrlje vidljive

90 Sličan je rožnjacima na Kozjaku kakve smo zabilježili na položaju Starosevski gaj (Perhoč 2009a).
91 Te nijanse boja su zamjetljive samo na najtanjim rubovima gledanjem prema svjetlu.
92 I ovaj primjer pokazuje koliko je temeljita mikrofacijelna analiza važna za preciznu klasifikaciju, statistiku i interpretaciju u materijalnoj analizi arheoloških nalaza. Naime, u ovoj podskupini moguć je i crni radiolarit sasvim druge provenijencije od opisanog crnog metasomatskog rožnjaka. Na crnom kamenu malih i patiniranih artefakata izrađenih od jezgrenog dijela stijene (bez sačuvane nodularne, valutične okorine ili međuslojne plohe), nemoguće je makroskopski razlikovati matasomatski rožnjak od radiolarita. Nodularni crni rožnjak iz Stračinčice kod Vele Luke na Korčuli, primjerice, vrlo je sličan crnom radiolaritu iz Lasinje.

A more thorough characterization of the artefact is not possible without destroying it. Whether or not such finds belong to this sub-group may be established only on the basis of a polished section, which means that the margin of error in macroscopic classification without microfacial control is higher than in other groups. Such a chert is frequent among the metasomatic cherts, and based on the type of host limestone, we have assumed the existence of a Dalmatian deposit which we have as yet not been able to pinpoint with any certainty.[90]

7.3.4. Black cherts

The black chert group (Fig. 9) encompasses 679 finds (14.76% of the total number) with a weight share of 15.02%. The stone has a waxy glassy lustre, with varying degrees of translucence and marked conchoidal fraction, and occasional faceted fraction surfaces, and smooth and sharp edges. Based on the grey-black and greenish nuances, one may provisionally speak of two types.[91] The chert is mostly metasomatic in origin.[92] This is indicated by so-called fossil "ghosts," round or irregular generally lighter stains

90 The situation is similar with the cherts on Kozjak as noted at the Starosevski Gaj site (Perhoč 2009a).
91 These nuances were noticeable only at the thinnest edges when viewed in light.
92 This example also shows how important a thorough microfacial analysis is to precise classification, statistics and interpretation in the material analysis of archaeological finds. For black radiolarites of entirely different origin than the described metasomatic chert are possible in this sub-group. On the black stone of small and patinated artefacts made of the core portion of rocks (without preserved nodular, pebble rinds or interstitial surfaces), it is impossible to macroscopically distinguish between metasomatic chert and radiolarite. The nodular black chert from Stračinčica near Vela Luka on the island of Korčula, for example, is very similar to the black radiolarite from Lasinja.

prostim okom.[93] U nabrusku su pored rijetkih crvenih zrnaca, vidljive dominante crne nepravilne mrlje organske tvari koja ovom rožnjaku daje boju (sl. 17).

Izrazito crne metasomatske rožnjake izvanredne kakvoće za sada smo zabilježili na položajima Stračinčica kod Vele Luke na Korčuli i Labinska draga na Oporu.[94]

7.4. Skupina nalaza raznovrsne petrografije

Posljednju malobrojnu skupinu artefakata (285 nalaza, brojčani udio 6,19 %, težinski 3,86 %,) čine petrografski heterogeni nalazi (sl. 9) koje nismo posebno klasificirali.[95] U ovoj skupini pojedinačno izdvajamo dvije tehnološke predjezgre preparirane od subangularnih valutica s debelo patiniranom okorinom (crvenosmeđi tonovi) po postanku tipičnoj za ilovaste ili slične sedimente s povećanom koncentracijom željezovitih minerala. Valutična okorina potpuno se razlikuje od jezgre, koja je u jednom slučaju zelenkasta, u drugom crna. Nalazi ovakvih značajka ukazuju na izvore sirovine tipa riječnih i potočnih prudova.

7.5. Žareni rožnjaci

Skupinu žarenih rožnjaka (sl. 9) čine artefakti na koje je djelovala visoka temperatura, u našem slučaju vatra ognjišta na staništu. Težinski udio skupine iznosi 10,16 %, a 862 nalaza čini 18,7 % od ukupnog broja.[96] Izravan utjecaj vatre na rožnjak vidljiv je u promjeni boje kamena, strukture i smanjene specifične težine. Nalazi su najčešće svjetlonepropusne sive, crne ili crvenkaste boje, bez sjaja i s tipičnom mrežom prslina koje nastaju zbog napetosti uzrokovanih grijanjem i hlađenjem kamena (sl. 18).

Nalaze na koje je djelovala visoka temperatura potrebno je statistički izdvojiti kako bi se moglo ustanoviti jesu li termički tretirani. Struktura žarenih kopačinskih artefakata odaje da je kamen tehnički neuporabiv i prema tome slučajno dospio u izravan dodir s ognjištem. Njihovu relativnu brojnost tumačimo malim prostorom pećine u kojoj se očito često ložilo, što ukazuje na trajnost ili učestalost boravka.

8. Kulturna stratigrafija - novi pogled

Kako smo već istaknuli, prema dostupnim podacima u dosad objavljenoj literaturi, u Kopačini su izdvojene tri kulturne faze ljudskog boravka: kasnogornjopaleolitička, mezolitička i brončanodobna. Ovdje je tehno-tipološki obrađen cjelokupni litički skup nalaza iz Kopačine, iako je u unutrašnjem dijelu

93 Tišljar 2004, str. 217. U ovoj podskupini nalaza nisu isključeni artefakti od silicificiranog šejla, siltita i tufa.
94 Usp. Perhoč 2009a.
95 Ti su nalazi snažno patinirani, razlomljenih ploha ili naprosto zamrljani zemljom i teško petrografski odredivi.
96 Na odnos broja i težine utječe gubitak higroskopne vode pri paljenju.

visible to the naked eye.[93] In the polished section, besides rare red grains, the dominant black irregular stains of organic matter are visible, which give this chert its colour (Fig. 17).

Distinctly black metasomatic cherts of extraordinary quality have for now been recorded at the sites at Stračinčica near Vela Luka on Korčula and Labinska draga on Opor.[94]

7.4. Group of finds with various petrography

The final small group of artefacts (285 finds, numerical share 6.19%, weight 3.86%) consists of petrographically heterogeneous finds (Fig. 9) which we did not specifically classify.[95] In this group, we individually distinguished two technological sub-cores prepared from sub-angular pebbles with a thickly patinated cortex (red-brown tones) formed typically for loam or similar sediments with an increased concentration of ferrous minerals. The rind of pebbles is entirely different from the core, which is greenish in one case, and black in another. Finds with such features indicate sources of raw materials of a type from riverine and stream sandbars.

7.5. Burned cherts

The group of burned cherts (Fig. 9) consists of artefacts affected by high temperatures, in this case the fire of a hearth in the dwelling. The weight share of the group is 10.16%, while the 862 finds account for 18.7% of the total number.[96] The direct impact of fire on the chert is visible in the change in the stone's colour, structure and reduced specific weight. The finds are most often opaque grey, black or reddish, without lustre and with the typical lattice of cracks which emerged as a result of the tension caused by heating and cooling of the stone (Fig. 18).

The finds affected by high temperatures must be statistically separated in order to establish whether they had been heat treated. The structure of the fired Kopačina artefacts indicate that the stone was technically unusable and thus came into direct contact with the hearth by chance. We interpret their relatively high number as a result of the small size of the cave in which fires were often stoked, which testifies to permanency or frequency of residence.

8. Cultural stratigraphy - a new look

As already stressed above, according to available data in the literature thus far published, three cultural phases of human habitation have been distinguished in Kopačina: late Upper Palaeolithic, Mesolithic and Bronze Age. Here the entire lithic

93 Tišljar 2004, p. 217. Artefacts made of silicified shale, siltite and tufa were not excluded from this group.
94 Cf.. Perhoč 2009a.
95 These finds are highly patinated, with broken surfaces, or they are simply smudged with soil and difficult to determine petrographically.
96 The ratio between number and weight is influenced by the loss of hygroscopic water at ignition.

pećine, prema literaturi, zabilježen i brončanodobni sloj na dubinama od 0-70 cm. Brončanodobni sloj dokumentiran je prisutnošću keramike i jedne brončane sjekire.[97] Litički skup nalaza iz dubina od 0-70 cm iz unutrašnjeg dijela pećine malobrojan je i pokazuje veliku tehno-tipološku sličnost s onim iz većih dubina, tako da se činilo opravdanim uključiti ovaj dio litičkog skupa nalaza u analizu. Smatramo da je litički materijal pronađen u kontekstu s brončanodobnom keramikom stariji, odnosno gornjopaleolitički, a kontekst u kojem je pronađen mogao bi biti posljedica miješanja sedimenata uzrokovanog aktivnostima koje su brončanodobni ljudi obavljali u samoj pećini. Za ti pretpostavku nemamo terenske podatke, ali spomenuta tehno-tipološka sličnost ide joj u prilog. Slična situacija zabilježena je u pećini Badanj na Hvaru, gdje su pločice s hrptom pronađene u kontekstu s neolitičkom hvarskom keramikom, vjerojatno kao posljedica određenog miješanja paleolitičkih i neolitičkih slojeva. Nekoliko apsolutnih datuma, kasnoglacijalne starosti, iz slojeva s hvarskom keramikom i pločicama s hrptom također ukazuje na ovu mogućnost.[98]

assemblage Kopačina has been techno-typologically analyzed, although according to the literature, a Bronze Age layer at depths of 0-70 cm has been recorded in the cave's interior. The Bronze Age layer has been documented by the presence of ceramics and one bronze axe.[97] The lithic assemblage from depths of 0-70 cm from the cave's interior are few in number and exhibit a high techno-typological similarity to those from greater depths, so that it would appear justified to encompass this portion of the lithic assemblage in the analysis. We consider the lithic material found in the context of the Bronze Age pottery older, i.e., Upper Palaeolithic, while the context in which it was found may be a result of mixing of sediments caused by activities carried out by the Bronze Age people in the cave itself. There are no field data to back this hypothesis, but the aforementioned techno-typological similarity would appear to uphold it. A similar situation was recorded in Badanj Cave on Hvar, where backed bladelets were found in a context with Neolithic Hvar pottery, probably as a result of a certain mixing of Palaeolithic and Neolithic layers. Several absolute dates of Late Glacial age from the layers with Hvar pottery and backed bladelets also suggest this possibility.[98]

Što je mezolitičko u Kopačini?

Glavni argument za pripisivanje dijela stratigrafskog slijeda mezolitiku vjerojatno bi bio ranoholocenski datum (Z-778) dobiven radiokarbonskim datiranjem kućica kopnenih puževa. Već smo spomenuli da je pouzdanost ovako dobivenih datuma vrlo upitna. Sama prisutnost velike količine kopnenih puževa u pećini također bi mogla upućivati na mezolitičku starost slojeva. Međutim, iako se kopneni puževi vrlo često pronalaze kao ostaci mezolitičkih obroka u pećinama u cirkummediteranskom prostoru, oni su česti i u kasnom gornjem paleolitiku.[99] Nekoliko probušenih *Columbella rustica*, koje su jako česte u mezolitiku istočnog Jadrana,[100] pronađeno je i u novim istraživanjima u Kopačini,[101] ali probušene *Columbelle rustice* na Jadranu pronalazimo i u kasnom gornjem paleolitiku.[102]

Smatramo da osim brončanodobne faze, ostatak stratigrafskog slijeda iz pećine Kopačine geokronološki najvjerojatnije pripada kasnom glacijalu, a kulturno-kronološki kasnom gornjem paleolitiku, odnosno kasnom epigravetijenu. Dva apsolutna datuma iz Kopačine (tablica 1) koji pripadaju kasnom glacijalu (Z-2403, Z-2404) idu u prilog ovom prijedlogu, a pogotovo zato što mlađi datum pripada samom vrhu stratigrafskog slijeda (rasponu dubine od 20-40 cm). Prosječna minimalna stopa taloženja u Kopačini mogla

What in Kopačina is Mesolithic?

The principal argument for ascribing a part of the stratigraphic sequence to the Mesolithic would probably be the early Holocene date (Z-778) obtained by radiocarbon dating of the land snail shells. It has already been noted that the reliability of dates so obtained is rather precarious. The very presence of a high quantity of land snails may also indicate the Mesolithic age of the layers. However, even though land snail shells are often found as the remains of Mesolithic meals in caves of the circum-Mediterranean zone, they were also frequent in the late Upper Palaeolithic.[99] Several perforated *Columbella rustica* shells, which were quite frequent in the Mesolithic of the Eastern Adriatic,[100] were also found in more recent research in Kopačina,[101] but perforated *Columbella rustica* shells in the Adriatic zone can also be found in the late Upper Palaeolithic.[102]

We consider that besides the Bronze Age phase, geochronologically the remainder of the stratigraphic sequence in Kopačina Cave most likely belongs to the Late Glacial, and culturally-chronologically to the late Upper Palaeolithic or, more specifically, the late Epigravettian. The two absolute dates from Kopačina (Table 1) which belong to the Late Glacial period (Z-2403, Z-2404) support this proposal, particularly since the more recent date belongs to the very top of the stratigraphic sequence (depth range of 20-40 cm). The average minimum sedimentation rate in Kopačina may have

97 Čečuk 1996, str. 18, 19.
98 Forenbaher 2002, str. 364.
99 Lubell 2004a; Lubell 2004b.
100 Komšo 2007, str. 35, 36; Čečuk, Radić 2005, str. 57.
101 Kliškić 2008, str. 529. Pronađene su izvan arheološkog konteksta, u sedimentu iskopanom u prethodnim iskopavanjima.
102 Bietti 1990, str. 133; Brusić 2008, str. 402; Komšo 2007, str. 34.

97 Čečuk 1996, pp. 18-19.
98 Forenbaher 2002, p. 364.
99 Lubell 2004a; Lubell 2004b.
100 Komšo 2007, pp. 35, 36; Čečuk and Radić 2005, p. 57.
101 Kliškić 2008, p. 529. Found outside of an archaeological context, in a sediment excavated in prior excavations.
102 Bietti 1990, p. 133; Brusić 2008, p. 402; Komšo 2007, p. 34.

bi biti u rasponu od 0,056 do 0,078 cm po radiokarbonskoj godini,[103] a maksimalna u rasponu od 0,167 do 0,233 cm po radiokarbonskoj godini.[104] U slučaju minimalne brzine za taloženje gornjih 40 cm stratigrafskog slijeda bilo bi potrebno između približno 715 i 510 radiokarbonskih godina, a kod maksimalne brzine taloženja bilo bi potrebno između približno 240 i 170 radiokarbonskih godina. U oba slučaja, sam vrh stratigrafskog slijeda pripadao bi vremenu kasnoga glacijala. Ove procjene su vrlo grube zbog nedostatka terenskih podataka po kojima bi se mogla napraviti nešto preciznija procjena. Uzimajući u obzir rezultate dobivene za pripećke Klithi[105] i Badanj,[106] vjerojatnija je procjena obroka taloženja u rasponu od 0,056 do 0,078 cm po radiokarbonskoj godini. Za Kopačinu se može pretpostaviti čak i nešto niža stopa taloženja od navedene, jer je taloženje u pripećcima kakvi su Klithi i Badanj brže, zahvaljujući erodiranom materijalu s okolnih klifova i padina koje okružuju pripećak, nego u pećinama.[107] Litički skup nalaza pokazuje veliku tehno-tipološku sličnost kroz cijeli stratigrafski slijed, unatoč izdvojenim dvjema fazama. Unutar LF II ne primjećuju se razlike koje bi se mogle interpretirati kao kasnogornjopaleolitičke, odnosno mezolitičke. Ako u Kopačini zaista postoje mezolitički ostaci, onda ih nije moguće detektirati u litičkom skupu nalaza. U tom slučaju postoji tehno-tipološki kontinuitet, kao i kontinuitet u iskorištavanju sirovina, na prijelazu iz pleistocena u holocen. Prema tome, kasni gornji paleolitik i mezolitik ne bi se mogli odvojiti u Kopačini na temelju kamenih artefakata, što bi bila situacija vrlo slična onoj u južnoj i srednjoj Italiji, gdje se finalni epigravetijen i mezolitik ne mogu razlikovati na temelju litičkih nalaza.[108] Pouzdana apsolutna datiranja i podaci o paleoklimi i okolišu pomogla bi u rasvjetljavanju prijelaza iz pleistocena u holocen u Kopačini, ako ta prijelazna faza zaista postoji.

ranged from 0.056 to 0.078 cm per radiocarbon year,[103] while the maximum range could have been 0.167 to 0.233 cm per radiocarbon year.[104] In case of the minimum rate of sedimentation in the upper 40 cm of the stratigraphic sequence, this would have required approximately 710 and 510 radiocarbon years, while in case of the maximum sedimentation rate, it would require roughly 240 and 170 radiocarbon years. In both cases, the actual top of the stratigraphic sequence would fall into the Late Glacial. These approximations are very rough due to the absence of field data that would allow for a more precise estimate. Taking into consideration the results obtained from the abris at Klithi[105] and Badanj,[106] a likely estimate for the sedimentation rate ranges from 0.056 to 0.078 cm per radiocarbon year. For Kopačina, one may assume an even lower sedimentation rate than the one proposed, for sedimentation in abris such as Klithi and Badanj proceeds more rapidly, thanks to eroding material from the surrounding cliffs and slopes which encircle it, than in actual caves.[107] The lithic group of finds exhibits a high techno-typological similarity over the entire stratigraphic sequence, despite the division into two phases. Within LP II no differences can be discerned which could be interpreted as late Upper Palaeolithic or Mesolithic. Insofar as there are truly Mesolithic remains in Kopačina, then they could not be detected in the lithic assemblage. In this case there is techno-typological continuity, as well as continuity in use of raw materials at the Pleistocene-Holocene transition. Therefore, the late Upper Palaeolithic and the Mesolithic could not be distinguished in Kopačina on the basis of stone artefacts, which would be quite similar to the situation in southern and central Italy, where the final Epigravettian and Mesolithic cannot be distinguished on the basis of lithic finds.[108] Reliable absolute dating and data on the palaeoclimate and environment would help to shed light on the Pleistocene-Holocene transition in Kopačina, in case this transition actually exists on this site.

9. Regionalni kontekst kasnoglacijalnih industrija istočnog Jadrana i zaleđa

9.1. Istra

Na prostoru Istre poznato je nekoliko nalazišta iz kasnoga glacijala. Litički skup nalaza iz Kopačine uspoređivat ćemo s jedne strane sa Šandaljom II, a s druge strane sa skupinom nalazišta

9. Regional context - Late Glacial industry of the Eastern Adriatic and its hinterland

9.1. Istria

Several Late Glacial sites are known in Istria. The lithic assemblage from Kopačina shall be compared, on one hand, with Šandalja II, while on the other with the group of sites including Vešanska,

103 Procjena prosječnog minimalnog obroka taloženja izračunata je na temelju maksimalnog vremenskog raspona (oko 1800 radiokarbonskih godina) za dva kasnoglacijalna datuma iz Kopačine kod pretpostavljene debljine sloja od 100 i 140 cm.
104 Procjena prosječnog maksimalnog obroka taloženja izračunata je na temelju minimalnog vremenskog raspona (oko 600 radiokarbonskih godina) za dva kasnoglacijalna datuma iz Kopačine kod pretpostavljene debljine sloja od 100 i 140 cm.
105 Bailey, Woodward 1997, str. 83, T. 4.1.
106 Bailey, Galanidou 2009, str. 227.
107 Bailey, Galanidou 2009, str. 231.
108 Bietti 1990, str. 131.

103 An estimate of the average minimum sedimentation rate has been computed on the basis of the maximum time span (ca. 1800 radiocarbon years) for the two late glacial dates from Kopačina with reference to the assumed layer thicknesses of 100 and 140 cm.
104 An estimate of the maximum sedimentation rate has been computed on the basis of the minimum time span (ca. 600 radiocarbon years) for the two late glacial dates from Kopačina with reference to the assumed layer thicknesses of 100 and 140 cm.
105 Bailey, Woodward 1997, p. 83, P. 4.1.
106 Bailey, Galanidou 2009, p. 227.
107 Bailey, Galanidou 2009, p. 231.
108 Bietti 1990, p. 131.

koju čine Vešanska, Nugljanska i Pupićina peć. U Šandalji II kao i u Kopačini otkriveni su veliki litički skupovi nalaza,[109] dok su Vešanska, Pupićina i Nugljanska peć dale desetke puta manje skupove nalaza od prethodno spomenutih. Na temelju litičke industrije Šandalje II i Kopačine možemo pretpostaviti da se radi o dugotrajnijim osnovnim staništima (*residential base*) ili jednostavno o točkama u kasnoglacijalnom okolišu koje su posjećivane učestalo. Za razliku od Šandalje II i Kopačine, u Nugljanskoj, Vešanskoj i Pupićinoj peći, boravci kasnoglacijalnog čovjeka bili su puno rjeđi.

Slojevi C/s iz Šandalje II s određenom radiokarbonskom starošću od 13.120 ± 230 BP (Z-2424),[110] B/C sa starošću od 13.050 ± 220 BP (Z-2423),[111] B/s 12.320 ± 100 BP (GrN-4978)[112] i B/g sa starošću od 10.830 ± 50 BP (GrN-4976)[113] pripadaju kasnom glacijalu i mogu se kronološki povezati s kopačinskim datumima, iako najmlađi datum iz Šandalje II donekle iskače iz ove usporedbe jer je za nekih 1000 radiokarbonskih godina mlađi od najmlađega kasnoglacijalnog datuma iz Kopačine. Radiokarbonska starost sloja B/d od 10.140 ± 160 BP (Z-2421) i 10.990 ± 60 BP (CAMS-12062)[114] odudara od datuma dobivenih za sloj B/s. P. Miracle pretpostavlja vrijeme taloženja slojeva B/d i B/s okvirno između 13.000 i 11.000 godina prije sadašnjosti,[115] dok I. Karavanić smatra da je cijeli kompleks B taložen prije približno 10000 godina.[116] Dugotrajnije taloženje šandaljskih sedimenata čini se vjerojatnijim.

Iako postoje kronološke paralele između šandaljskih datuma za sloj C/s i B/C i kopačinskih datuma, ovdje ćemo se ograničiti samo na usporedbu litičkog skupa nalaza iz Kopačine s onim iz B kompleksa Šandalje II, jer litički skup nalaza iz sloja C/s i C/g, kao i onaj iz sloja B/C nije moguće pouzdano interpretirati.[117]

U svim slojevima kompleksa B odbojci su dominanti, s relativnom učestalošću od preko 50 % (B/d oko 56 %, B/s 53 % i B/g 50 %).[118] Odbojci dominiraju i u obje litičke faze Kopačine. Za razliku od litičkog skupa nalaza iz Kopačine u kojem je relativna učestalost pločica u obje litičke faze jako mala (vidi tablice 3 i 5), u sva tri sloja B kompleksa Šandalje II pločice su puno češće proizvođene (relativna učestalost u sva tri sloja je oko 11 %). Iako su sječiva u Šandalji II nešto brojnija negoli u Kopačini, razlika nije tako jako izražena kao kod pločica. Udio jezgara u litičkom skupu nalaza Kopačine razmjerno je visok (LF I oko 9 %, LF II 12 %), uspoređuje li se sa Šandaljom (B/d oko 5 %, B/s 6 %, B/g 6 %). Iako su razlike između sloja B/d s jedne strane i slojeva B/s i B/g s druge strane jasno istaknute,[119] ovdje ćemo, promatrano kroz formalno obrađene artefakte, tj. alatke, usporediti litički skup nalaza iz Kopačine s cjelokupnim kompleksom B iz Šandalje II. U Kopačini kao i u Šandalji II najzastupljeniji pojedinačni tip alatki su komadići s obradom. Iako su na oba nalazišta grebala iznimno brojna, u Kopačini su ona brojnija i puno je veća zastupljenost noktolikih grebala negoli u Šandalji II. S druge strane, udio pločica s hrptom i mikrograveta znatno je manji u Kopačini (tablica 4 i 6) negoli u Šandalji II.[120] Geometrijski mikroliti koji se u Kopačini pojavljuju u obje faze prisutni su i u šandaljskom B kompleksu, ali samo u slojevima B/s i B/g. U Šandalji II je relativna učestalost geometrijskih mikrolita veća nego u Kopačini, a i repertoar tipova također je veći u Šandalji II (kružni segment i pravokutnik iz Kopačine nasuprot kružnom segmentu, pravokutniku, trokutu i trapezu iz Šandalje II). Iskrzani komadići puno su zastupljeniji u Kopačini (LF I 8,42 %; LF II 8,45 %) nego u Šandalji II (B/d 2,1 %; B/s 5,1 %; B/g 3,3 %). Udio azilijenskih šiljaka u Šandalji II raste od starijih prema mlađim slojevima kompleksa B,[121] dok su zakrivljeni šiljci s hrptom u Kopačini brojniji u starijoj negoli u mlađoj fazi.[122]

Iako postoje brojne tehno-tipološke sličnosti između šandaljske i kopačinske industrije, ovdje su istaknute i brojne razlike.

Nekoliko apsolutnih radiokarbonskih datuma iz Vešanske peći pokazuje znatnu vremensku podudarnost s Kopačinom. Kasnoglacijalni stratigrafski slijed iz Vešanske peći apsolutnokronološki se može smjestiti u rasponu od 12.490 ± 100 BP (OxA-8443)[123] do 11.410 ± 90 BP (Beta-127706).[124] U najstarijem kasnoglacijalnom horizontu Vešanske peći pronađeno je samo pet artefakata,[125] zbog čega ćemo ga izuzeti iz daljnje komparacije. U sljedećem horizontu iz Vešanske koji nije datiran, ali je označen kao *Interstadial phase I*[126] i nešto je stariji od oko 11.500 BP, pronađen je litički skup nalaza u kojem u tehnološkom smislu dominiraju odbojci i krhotine, s velikom relativnom učestalošću pločica, a među alatkama dominiraju strmo obrađeni artefakti, među kojima su najbrojnije pločice i šiljci s hrptom.[127] Ovakav skup nalaza vjerojatno je uvjetovan lovnim aktivnostima skupine koja

Nugljanska and Pupićina Caves. Large lithic assemblages were discovered in both Šandalja II and in Kopačina,[109] while Vešanska, Pupićina and Nugljanska Caves had several times smaller assemblages. Based on the lithics industry of Šandalja II and Kopačina, we may assume that these residential bases or simply points in the Late Glacial environment that were frequently visited. As opposed to Šandalja II and Kopačina, in Nugljanska, Vešanska and Pupićina Caves, visits by Late Glacial people were much more rare.

Layers C/s from Šandalja II, with a determined radiocarbon age of 13120 ± 230 BP (Z-2424),[110] B/C with an age of 13050 ± 220 BP (Z-2423),[111] B/s 12 320 ± 100 BP (GrN-4978)[112] and B/g with an age of 10830 ± 50 BP (GrN-4976)[113] belong to the Late Glacial period and may be chronologically linked to the Kopačina dates, even though the youngest date from Šandalja II deviates somewhat from this comparison because it is roughly ca. 1000 radiocarbon years younger than the youngest Late Glacial date from Kopačina. The radiocarbon age of layer B/d of 10140 ± 160 BP (Z-2421) and 10990 ± 60 BP (CAMS-12062)[114] deviates from the date obtained for layer B/s. P. Miracle assumed a sedimentation time between roughly 13 ,000 and 11,000 years before the present for layers B/d and B/s,[115] while I. Karavanić believes that the entire B complex was deposited roughly 10,000 years ago.[116] The longer-term sedimentation of the Šandalja sediments appears likely.

Although there are chronological parallels between the Šandalja dates for layers C/s and B/C and the Kopačina dates, here we shall restrict ourselves only to a comparison of the lithic assemblage from Kopačina with those from the B complex of Šandalja II, for the lithic assemblages from layers C/s and C/g, like that from layer B/C, could not be reliably interpreted.[117]

In all layers of complex B, flakes predominated with a relative frequency of over 50% (B/d ca. 56%, B/s 53% and B/g 50%).[118] Flakes also dominated in both lithic phases of Kopačina. As opposed to the lithic assemblage from Kopačina in which the relative frequency of bladelets in both lithic phases is very small (see Tables 3 and 5), in all three layers of the B complex of Šandalja II, the bladelets were more frequently produced (relative frequency in all three layers is ca. 11%). Even though the blades in Šandalja II are somewhat more numerous than in Kopačina, the difference is not as distinctive as in the case of bladelets. The share of cores in the lithic assemblage of Kopačina is relatively high (LF I ca. 9%, LF II 12%) if compared to Šandalja (B/d ca. 5%, B/s 6%, B/g 6%). Even though the differences between layer B/d on the one hand and layers B/s and B/g on the other are clearly notable,[119] here we shall compare the lithic assemblage from Kopačina with the entire B complex from Šandalja II through the prism of formally retouched artefacts, i.e. tools. In Kopačina, as in Šandalja II, the most common individual tool type is retouched piece. Although endscrapers are quite numerous at both sites, in Kopačina they are more numerous and there is a higher instance of thumbnail endscrapers than in Šandalja II. On the other hand, the share of backed bladelets and micro-Gravettes is considerably lower in Kopačina (Tables 4 and 6) than in Šandalja II.[120] The geometric microliths which appear in Kopačina in both phases are also present in the Šandalja B complex, but only in layers B/s and B/g. Relative frequency of geometric microliths is greater in Šandalja II than in Kopačina, while the repertoire of types is also greater than in Šandalja II (segment and rectangle from Kopačina as opposed to the segment, rectangle, triangle and trapeze from Šandalja II). Splintered pieces are much more present in Kopačina (LF I 8.42%; LF II 8.45%) than in Šandalja II (B/d 2.1%; B/s 5.1%; B/g 3.3%). The share of Azilian points in Šandalja II increases from the older to younger layers of the B complex,[121] while curved backed points in Kopačina are more numerous in the older than in the younger phase.[122]

Although there are numerous techno-typological similarities between the Šandalja and Kopačina industries, here numerous differences also stand out.

Several absolute radiocarbon dates from Vešanska Cave show a considerable chronological correspondence with Kopačina. The Late Glacial stratigraphic sequence from Vešanska Cave can be absolutely chronologically dated within the span of 12490 ± 100 BP (OxA-8443)[123] to 11410 ± 90 BP (Beta-127706).[124] In the oldest Late Glacial horizon of Vešanska Cave, only 5 artefacts were discovered,[125] which is why we shall exclude them from further comparison. In the subsequent horizon from Vešanska which has not been dated, but has been designated as Interstadial Phase I [126] and is somewhat older than ca. 11,500 BP, a lithic assemblage was discovered which is dominated by flakes and chunks, with a high relative frequency of bladelets, while among the tools backed artefacts predominate, with backed bladelets and backed points being the most numerous.[127] Such a lithic assemblage is probably a result of the hunting activities of the group

109 Karavanić 1999.
110 Obelić et al. 1994, str. 305.
111 Obelić et al. 1994, str. 304.
112 Malez, Vogel 1969, str.129.
113 Malez, Vogel 1969, str. 129.
114 Miracle 1995, str. 92, T. 3.3.
115 Miracle 1995, str. 93.
116 Karavanić 1999, str. 93.
117 Karavanić 1999, str. 91.
118 Karavanić 1999, str. 70, T. 26, str. 73, T. 28, str. 78, T. 30. Treba spomenuti da se navedeni podaci odnose samo na neobrađene artefakte.

109 Karavanić 1999.
110 Obelić et al. 1994, p. 305.
111 Obelić et al. 1994, p. 304.
112 Malez, Vogel, 1969, p.129.
113 Malez, Vogel, 1969, p. 129.
114 Miracle 1995, p. 92, P. 3.3.
115 Miracle 1995, p. 93.
116 Karavanić 1999, p. 93.
117 Karavanić 1999, p. 91.
118 Karavanić 1999, p. 70, P. 26, p. 73, P. 28, p. 78, P. 30. Worth mentioning is that these data pertain solely to unretouched artefacts.

119 Karavanić 1999, str. 93, 94.
120 Karavanić 1999, str. 72, T. 27, str. 76, T. 29, str. 80, T. 31.
121 Karavanić 1999, str. 72, T. 27, str. 76, T. 29, str. 80, T. 31
122 Mi ovdje rabimo termin zakrivljeni šiljci s hrptom *(pointe a dos courbe*) prema Demars, Laurent 1992, str. 112, koji drže da se zakrivljeni šiljci s hrptom pojavljuju u isto vrijeme kad i noktolika grebala, tj. u kasnoglacijalnim industrijama Europe, a u literaturi su poznati pod različitim imenima: *pointe azilienne, canif de Villepin, pointe deTjonger, Federmesser*.
123 Komšo, Pellegati 2007, str. 31.
124 Miracle, Forenbaher 2000, str. 44; Komšo, Pellegati 2007, str. 31.
125 Komšo, Pellegati 2007, str. 30.
126 Komšo, Pellegati 2007, str. 32.
127 Komšo, Pellegati 2007, str. 32.

119 Karavanić 1999, p. 93, 94.
120 Karavanić 1999, p. 72, P.27, p. 76, P.29, p. 80, P. 31.
121 Karavanić 1999, p. 72, P. 27, p. 76, P. 29, p. 80, P. 31
122 Here we are using the term curved backed points *(pointe a dos courbe*) based on Demars, Laurent 1992, p. 112. According to them, curved backed points appeared at the same time as thumbnail endscrapers, i.e., in the late glacial industries of Europe, while in the literature they are known under various names: *pointe azilienne, canif de Villepin, pointe deTjonger, Federmesser*.
123 Komšo, Pellegati 2007, p. 31.
124 Miracle, Forenbaher 2000, p. 44; Komšo, Pellegati 2007, p. 31.
125 Komšo, Pellegati 2007, p. 30.
126 Komšo, Pellegati 2007, p. 32.
127 Komšo, Pellegati 2007, p. 32.

je boravila u Vešanskoj peći. Sljedeća faza iz Vešanske (*Interstadial Phase II*) tehnološki i tipološki gledano pokazuje određene razlike u odnosu na prethodnu fazu, ali su i dalje među alatkama najbrojniji strmo obrađeni artefakti.[128] Repertoar alatki prisutan u Vešanskoj podudara se dobrim dijelom s onim pronađenim u Kopačini, ali se međusobni omjeri bitno razlikuju u jednoj i drugoj pećini i odraz su različitih aktivnosti poduzimanih u svakoj od pećina. Poduzimane aktivnosti nisu nužno potpuno različite, ali je različit njihov intenzitet. Za razliku od Kopačine gdje mikrodubila nisu prisutna, ona se u Vešanskoj peći pojavljuju u ovoj najmlađoj fazi.[129]

Dio stratigrafskog slijeda iz Pupićine peći koji pripada kasnom glacijalu na temelju radiokarbonskih datuma može se smjestiti u rasponu od 11.150 ± 80 BP (Beta-145095) do 10.020 ± 180 BP (Z-2613).[130] Inicijalna faza je kao i u Vešanskoj peći dokumentirana malim brojem ostataka faune i litike. Iako između kasnijih dviju faza postoji određena razlika, u obje faze dominiraju odbojci i krhotine s približno jednakim udjelima, a udio pločica je znatno veći nego u Kopačini. U repertoaru alatki koji je sličan kopačinskom, dominiraju grebala, noktolika i kružna, udio strmo retuširanih artefakata je također veliki, a u kasnijoj fazi se u ovoj skupini alatki pojavljuju i geometrijski mikroliti. Mikrodubila su također prisutna u najkasnijoj fazi.[131]

Dio stratigrafskog slijeda iz Nugljanske peći na temelju radiokarbonske starosti od 11520 ± 90 (Beta-127705) može se smjestiti u kasnoglacijalno razdoblje.[132] I u Nugljanskoj kao i u Vešanskoj i Pupićinoj peći postoje određene razlike između različitih faza boravka u pećini koje su vjerojatno uvjetovane funkcijom same pećine u određenim razdobljima. Među tehnološkim kategorijama dominiraju odbojci uz poprilično visoki udio pločica i sječiva (u usporedbi s Kopačinom). Kod strmo retuširanih alatki dominantne su pločice s hrptom, a u mlađoj fazi se javljaju i geometrijski mikroliti. Mikrodubila su prisutna i u Nugljanskoj, i to u obje faze.

Uzimajući u obzir gore navedeno, možemo zaključiti: na istarskim nalazištima kao i u Kopačini odbojci predstavljaju primarni proizvod lomljenja; pločice su u Istri puno zastupljenije nego u Kopačini; dok su mikrodubila prisutna na gotovo svim spomenutim istarskim nalazištima (osim u Šandalji II, što može biti posljedica neprosijavanja sedimenta), ona nisu poznata u Kopačini; iskrzani komadi puno su rjeđi u Istri nego u Kopačini; udio grebala je velik i u Kopačini i u Istri, ali se čini da su noktolika grebala brojnija u Kopačini; geometrijski mikroliti prisutni su u Kopačini kao i na istarskim nalazištima.

which resided in Vešanska Cave. The subsequent phase from Vešanska (Interstadial Phase II), viewed technologically and typologically, exhibits some differences in relation to the preceding phase, although backed artefacts are still the most numerous among the tools.[128] The repertoire of tools present in Vešanska corresponds largely to that found in Kopačina, but their relative frequency significantly differs from one cave to the other, what could be a result of different activities undertaken in each cave. The activities undertaken were not necessarily entirely different, but their intensity differed. In contrast to Kopačina, where micro-burins are not present, they appeared in Vešanska in this youngest phase.[129]

A part of the stratigraphic sequence from Pupićina Cave which belongs to the Late Glacial period based on radiocarbon dating can be placed within the span from 11150 ± 80 BP (Beta-145095) to 10020 ± 180 BP (Z-2613).[130] The initial phase, as in Vešanska Cave, has a small documented number of animal and lithic remains. Although there are certain differences between the later two phases, both are dominated by flakes and chunks with roughly equal shares, while the share of bladelets is considerably higher than in Kopačina. The repertoire of tools, which is similar to that of Kopačina, is dominated by endscrapers, thumbnail and circular, while the share of backed artefacts is also high, and in the later phase geometric microliths also appear in this group of tools. Micro-burins are also present in the latest phase.[131]

A part of stratigraphic sequence from Nugljanska Cave, based on the radiocarbon age of 11520 ± 90 (Beta-127705), may be placed in the Late Glacial period.[132] In Nugljanska, as in Vešanska and Pupićina, there are certain differences between the different phases of residence in the cave which were probably dictated by the function of the cave itself in certain periods. Among the technological categories, flakes dominate, with a rather high share of bladelets and blades (in comparison to Kopačina). Among the backed tools, backed bladelets dominate, while in the younger phase geometric microliths also appear. Micro-burins are present in Nugljanska as well, in both phases.

Taking into account all of the aforementioned aspects, we may conclude as follows: at the Istrian sites as in Kopačina, flakes were the primary product of knapping; bladelets in Istria are much more common than in Kopačina; while micro-burins are present at almost all of the Istrian sites (except in Šandalja II, which may be due to the lack of sifting of sediments), they are unknown in Kopačina; splintered pieces are rarer in Istria than in Kopačina; the share of endscrapers is high in both Kopačina and Istria, but it would appear that thumbnail endscrapers are more numerous in Kopačina; geometric microliths are present in Kopačina as at the Istrian sites.

128 Komšo, Pellegati 2007, str. 32.
129 Komšo, Pellegati 2007, str. 32.
130 Komšo, Pellegati 2007, str. 33, sl. 3.5. Ovdje su navedena još tri datuma koja pripadaju spomenutom rasponu.
131 Komšo, Pellegati 2007, str. 34.
132 Komšo, Pellegati 2007, str. 35; Miracle, Forenbaher 1997, str. 41.

128 Komšo, Pellegati 2007, p. 32.
129 Komšo, Pellegati 2007, p. 32.
130 Komšo, Pellegati 2007, p. 33, Fig. 3.5. Here are cited three more dates which belong to the afore mentioned time span.
131 Komšo, Pellegati 2007, p. 34.
132 Komšo, Pellegati 2007, p. 35; Miracle, Forenbaher 1997, p. 41.

9.2. Dalmacija

Osim Kopačine, u Dalmaciji su nam poznata još tri kasnoglacijalna nalazišta (Vlakno, Zemunica, Vela spila). S pećinom Vlakno na Dugom otoku možemo povući samo vremensku paralelu jer materijal još nije objavljen. Kasnogornjopaleolitički lovci i skupljači u Vlaknu su boravili između 14.900 BP, utvrđena starost tefre,[133] i 10.160 ± 100 BP (Z-3383).[134]

Kao i u slučaju Vlakna, s pećinom Zemunicom možemo povući samo kronološku paralelu jer litički skup nalaza još nije objavljen, a dio stratigrafskog slijeda vjerojatno pripada kasnom gornjem paleolitiku.[135]

Kasnoglacijalni boravak lovačko-sakupljačkih zajednica u Veloj spili određen je jednim apsolutnim radiokarbonskim datumom starosti 12.260 ± 40 BP (VERA-2346).[136] Uzimajući u obzir dobivenu starost i prisutne tipove alatki te njihovu relativnu učestalost, slojeve 8/2 - 8/6 promatrat ćemo kao cjelinu i usporediti ih s litičkom industrijom iz Kopačine. Dominantna tehnološka kategorija u kasnoglacijalnom litičkom skupu nalaza Vele spile su krhotine (izuzmemo li sitni otpad), nakon kojih slijede odbojci, zatim pločice i na kraju sječiva. Za razliku od Kopačine, pločice i sječiva u Veloj spili proizvođena su puno češće.[137] U litičkom inventaru Vele spile autori ne spominju prisutnost mikrodubila.[138] U litičkom skupu nalaza Vele spile među alatkama dominiraju grebala, što je slučaj i u Kopačini u obje litičke faze, ali su ona znatno brojnija u Veloj spili, gdje čine gotovo 50 % svih alatki.[139] Među grebalima, noktolika su najbrojniji tip nakon grebala na odbojku, dok su noktolika grebala u Kopačini najbrojniji tip među grebalima. Relativna učestalost pločica s hrptom u Veloj spili (oko 12 %) puno je veća nego u Kopačini, ali to može biti posljedica neprosijavanja sedimenta u Kopačini. Među geometrijskim mikrolitima u Veloj spili najbrojniji su kružni segmenti, a prisutan je i samo jedan primjerak trapeza. Veća učestalost geometrijskih mikrolita u Veloj spili nego u Kopačini može biti rezultat, kao i kod pločica s hrptom, metodologije iskopavanja. Relativna učestalost iskrzanih komadića podjednaka je na oba nalazišta. Zakrivljeni šiljci s hrptom brojniji su u Kopačini nego u Veloj spili (0,38 %). Na temelju iznesenog možemo zaključiti da kasnoglacijalne litičke industrije Vele spile i Kopačine pokazuju znatnu sličnost.

9.2. Dalmatia

Besides Kopačina, three other Late Glacial sites (Vlakno, Zemunica, Vela spila) are known in Dalmatia. Only a chronological parallel can be drawn with Vlakno Cave on the island of Dugi otok, because the materials have not yet been published. The late Upper Palaeolithic hunter-gatherers resided in Vlakno between 14,900 BP, established by the age of the tephra,[133] and 10160 ± 100 BP (Z-3383).[134]

As in the case of Vlakno, only a chronological parallel can be drawn for Zemunica Cave, because the lithic assemblage has not yet been published, while part of the stratigraphic sequence probably belongs to the late Upper Palaeolithic.[135]

The Late Glacial stay of hunter-gatherers in Vela Spila has been determined by an absolute radiocarbon date to an age of 12260 ± 40 BP (VERA-2346).[136] When taking into consideration the age and tool types present, as well as their relative frequency, layers 8/2 - 8/6 will be observed as a whole and compared to the lithic industry from Kopačina. The dominant technological category in the Late Glacial lithic assemblage of Vela Spila are chunks (with the exception of chips), followed by flakes, and then bladelets and finally blades. As opposed to Kopačina, bladelets and blades were produced much more often in Vela Spila.[137] The authors did not mention the presence of micro-burins in the lithic inventory of Vela Spila.[138] In the lithic asemblage of Vela Spila, endscrapers predominate among the tools, which is also the case in Kopačina in both lithic phases, but they are much more numerous in Vela Spila, where they compose almost 50% of all tools.[139] Among the endscrapers, the thumbnail endsraper is the most numerous type after endscrapers on flakes, while thumbnail endscrapers in Kopačina are the most numerous type among the endscrapers. The relative frequency of backed bladelets in Vela Spila (ca. 12%) is much higher than in Kopačina, but this may be a result of the absence of sifting of sediments in Kopačina. Among the geometric microliths in Vela Spila, the most numerous are backed segments, and only one example of a trapeze is present. The higher frequency of geometric microliths in Vela Spila compared to Kopačina may, as in the case of backed bladelets, be the result of the excavation methodology. The relative frequency of splintered pieces is identical at both sites. Curved backed bladelets are more numerous in Kopačina than in Vela Spila (0.38%). Based on this, we may conclude that the Late Glacial lithic industries in Vela Spila and Kopačina exhibit considerable similarities.

133 Brusić 2008, str. 402.
134 Brusić 2005, str. 198; Komšo 2006, str. 74.
135 Šošić, Karavanić 2006, str. 378.
136 Čečuk, Radić 2005, str. 34, bilj. 9. Datiran je uzorak drvenog ugljena iz sloja 8/6.
137 Čečuk, Radić 2005, str. 26, tablica 2.
138 Čečuk, Radić 2005.
139 Podaci o relativnoj učestalosti alatki za Velu spilu dobiveni su na temelju podataka prikazanih u Čečuk, Radić 2005, str. 27, tablica 4.

133 Brusić 2008, p. 402.
134 Brusić 2005, p. 198; Komšo 2006, p. 74.
135 Šošić, Karavanić 2006, p. 378.
136 Čečuk, Radić 2005, p. 34, note 9. A charcoal sample from layer 8/6 was dated.
137 Čečuk, Radić 2005, p. 26, Table 2.
138 Čečuk, Radić 2005.
139 Data on the relative frequency of tools from Vela Spila were obtained on the basis of data shown in Čečuk and Radić 2005, p. 27, Table 4.

9.3. Hercegovina

Apsolutni radiokarbonski datumi iz Badnja pokazuju jasnu kronološku povezanost s Kopačinom. Stariji datum iznosi 13.200 ± 150 BP (OxA-2196), a mlađi 12.380 ± 110 BP (OxA-2197).[140] Barem dio stratigrafskog slijeda iz Kopačine istovremen je s onim iz Badnja. Tipološki gledano, u Badnju su izdvojene dvije faze,[141] pri čemu se mlađa faza, koja počinje oko 12.500 BP, može dobro korelirati s Kopačinom. Mlađu fazu u Badnju u glavnim crtama karakterizira dominacija noktolikih grebala (20,64,%) nad pločicama s hrptom, te pojava geometrijskih mikrolita (uglavnom kružnih segmenata),[142] što je u potpunom suglasju s Kopačinom s obje litičke faze, a posebno s mlađom. U Badnju, kao i u Kopačini, nije zabilježena tehnika mikrodubila. Iskrzani komadi uobičajeni su u Badnju kroz cijeli stratigrafski slijed,[143] kao i u Kopačini.

9.4. Crna Gora

Na nekoliko crnogorskih nalazišta utvrđeni su slojevi s kasnoglacijalnom epigravetijenskom industrijom koji se mogu komparirati s Kopačinom. To su Crvena stijena, Mališina stijena, Medena stijena i Trebački krš.[144] Kasnoepigravetijenske industrije iz Crvene stijene (slojevi IX i VIII), Medene stijene (slojevi VIII-V), Mališine stijene (sloj 2) i Trebačkog krša (sloj II) grupirane su kao *industries with arched backed bladelets and geometric tools* i pripadale bi prijelaznoj (Crvena stijena IX i Medena stijena VIII) i kasnoj fazi kasnoga gornjeg paleolitika u Crnoj Gori.[145] Dosad postoji samo jedan apsolutni datum s crnogorskih nalazišta koji pripada vremenu kasnoga gornjeg paleolitika. Sloj 3b1 iz Mališine stijene datiran je ^{14}C AMS metodom i dobivena je starost od 13.780 ± 140 BP (OxA-1894).[146]

Na spomenutim crnogorskim nalazištima tehnološki gledano dominiraju odbojci, kao i u Kopačini, a sječiva su puno češća nego u Kopačini, dok je osobito velika učestalost u Medenoj stijeni.[147] Mikrodubila su gotovo potpuno odsutna, zabilježen je samo jedan primjerak u Trbačkom kršu,[148] što je situacija vrlo slična onoj u Kopačini, gdje u potpunosti nedostaju. Iskrzani komadi zabilježeni su u Crvenoj stijeni i Medenoj stijeni, a u Trebačkom kršu nisu.[149] Dok je u Kopačini relativna učestalost dubila dosta mala, na crnogorskim nalazištima znatno je viša. Noktolika grebala puno su češća u Kopačini nego na bilo kojem od spomenutih nalazišta.[150] Geometrijski mikroliti i zarupci češći su na crnogorskim nalazištima nego u Kopačini. Pored dosta sličnosti, između Kopačine i crnogorskih nalazišta postoje i znatne razlike, koje su ovdje sumarno navedene.

Na temelju regionalne usporedbe možemo reći da najveću sličnost kopačinska industrija pokazuje s Badnjem (mlađom fazom) i s Velom spilom, što može biti povezano s geografskom bliskošću ovih nalazišta.

9.3. Herzegovina

The absolute radiocarbon dates from Badanj show a clear chronological link with Kopačina. The older date is 13200 ± 150 BP (OxA-2196), while the younger is 12380 ± 110 BP (OxA-2197).[140] At least a portion of the stratigraphic sequence from Kopačina is contemporaneous to that of Badanj. Based on typology, two phases have been distinguished in Badanj,[141] wherein the younger phase which commenced at around 12,500 BP may be correlated to Kopačina. The younger phase in Badanj is, in its general contours, characterized by the predominance of thumbnail endscrapers (20.64%) over backed bladelets, and the appearance of geometric microliths (mostly circular segments),[142] which complies entirely with Kopačina in both lithic phases, particularly with the younger. In Badanj, as in Kopačina, no micro-burin technique has been recorded. Splintered pieces are common in Badanj over the entire stratigraphic sequence,[143] as in Kopačina.

9.4. Montenegro

Layers containing Late Glacial Epigravettian industry have been confirmed at several Montenegrin sites which may be compared to Kopačina. These are Crvena stijena, Mališina stijena, Medena stijena and Trebački krš.[144] The late Epigravettian industry from Crvena stijena (layers IX and VIII), Medena stijena (layers VIII-V), Mališina stijena (layer 2) and Trebački krš (layer II) have been grouped as industries with curved backed bladelets and geometric tools and they belong to the transitional (Crvena stijena IX and Medena stijena VIII) and late phases of the late Upper Palaeolithic in Montenegro.[145] Thus far there is only a single absolute date from the Montenegrin site which belongs to the late Upper Palaeolithic. Layer 3b1 from Mališina stijena has been dated by C-14 AMS method and an age of 13780 ± 140 BP (OxA-1894) was obtained.[146]

At the aforementioned Montenegrin sites, flakes dominate in technological terms, as in Kopačina, while blades are much more frequent than in Kopačina, with a particularly high frequency in Medena stijena.[147] Micro-burins are almost entirely absent, only a single example was found in Trebački krš,[148] which is very similar to the situation in Kopačina, where they are entirely absent. Splintered pieces have been recorded in Crvena stijena and Medena stijena, but not in Trebački krš.[149] While in Kopačina the relative frequency of burins is rather minor, at the Montenegrin sites it is considerably higher. Thumbnail endscrapers are much more frequent in Kopačina than at any other of the aforementioned sites.[150] Geometric microliths and truncations are more frequent at the Montenegrin sites than in Kopačina. Besides considerable similarities, there are also considerable differences between Kopačina and the Montenegrin sites, which are summarily specified here.

Based on a regional comparison, we can say that the Kopačina industry shows the greatest similarity to Badanj (younger phase) and Vela Spila, which may be tied to the geographic proximity of these sites.

10. Zaključak

Litička analiza skupa nalaza iz Kopačine pokazala je mogućnost izdvajanja dviju faza, na temelju odnosa relativne učestalosti pločica s hrptom i zakrivljenih šiljaka s hrptom. Starija faza (LF I) trajala bi do ca. 13.200 BP, što je *terminus post quem non* za ovu fazu, dok za najstariji dio stratigrafskog slijeda iz Kopačine nemamo apsolutne datume koji bi odredili početak LF I. Trajanje mlađe faze (LF II) može se staviti između otprilike 13.200 i 12.000 BP, s tim da možemo pretpostaviti završetak ove mlađe faze nekoliko stotina radiokarbonskih godina kasnije. Iako između ove dvije faze postoje određene razlike u tipološkom smislu, puno su veće sličnosti. Na temelju litičke industrije i apsolutnih datuma, cjelokupni stratigrafski slijed iz Kopačine možemo kronološki odrediti kao kasnoglacijalni, a kulturno kao epigravetijenski, iako će možda revizijska istraživanja u budućnosti s novim apsolutnim datumima korigirati ovakve zaključke. Na temelju usporedbe s kasnoglacijalnim industrijama istočnog Jadrana i zaleđa, litički skup nalaza iz Kopačine najbliži je onima otkrivenima u Veloj spili i Badnju, što bi se dobro poklapalo s hipotetičkim heksagonalnim idealnim prostorom kretanja lovačko-sakupljačkih zajednica na Jadranu koji je predložio R. Whallon.[151]

Petrografska analiza litičkih artefakata iz pećine Kopačine, iako ograničena zahvata, podloga je geoarheološke skice ekonomije nabave litičke sirovine, a time i mreže kretanja kopačinske populacije u kasnoglacijalnom okolišu. Analizirani litički artefakti izrađeni su od metasomatskog rožnjaka i radiolarita. Izdvojeno je osam materijalnih skupina od kojih su tri zasigurno brački import. To su skupine crvenog, zelenog radiolarita i numulitnog rožnjaka s ukupno 12 % težinskog udjela. One su nedvojbeni dokaz o kretanjima kopačinske populacije na prostoru današnje srednje Dalmacije i regija na istočnoj strani Jadrana, vjerojatno sve do srednje Bosne. Te tri skupine zastupljene su u svim dubinama iskopanoga pećinskog sedimenta (manje u dubljim starijim slojevima), što govori o kontinuitetu pretpostavljene mreže kretanja lovaca i sakupljača iz Kopačine. Dok skupina numulitnog rožnjaka svjedoči o povezanosti otoka s obalnim pojasom, skupine zelenog i crvenog radiolarita malog udjela u litičkom

10. Conclusion

A lithic analysis of the Kopačina assemblage points to the possibility of existence of two lithic phases, based on relative frequency ratio between backed bladelets and curved backed points. The older phase (LP I) would have lasted until ca 13,200 BP, which is the *terminus post quem non* for this phase, while the oldest part of the stratigraphic sequence from Kopačina has no absolute dates that would designate the beginning of LP I. The duration of the younger phase (LP II) may be placed between ca 13,200 and 12,000 BP, although we may assume a close to this younger phase several hundred radiocarbon years later. Although there are certain differences between these two phases in typology, the similarities are much greater. Based on the lithic industry and the absolute dates, the entire stratigraphic sequence from Kopačina may be chronologically determined as Late Glacial, and culturally as Epigravettian, although revisionary research in the future, with new absolute dates, may correct such conclusions. Based on comparisons with the Late Glacial industries of the Eastern Adriatic and its hinterland, the lithic assemblage from Kopačina is most akin to those discovered in Vela Spila and Badanj, which would fit nicely with the hypothetical hexagonal ideal space of movement of hunter-gatherers along the Adriatic coast proposed by R. Whallon.[151]

The petrographic analysis of the lithic artefacts from Kopačina Cave, although a limited undertaking, provided the platform for a geoarchaeological sketch of the economy of procuring lithic raw materials, and also the network of movements of the Kopačina population in the Late Glacial environment. The analyzed lithic artefacts were crafted from metasomatic cherts and radiolarites. Eight materials groups have been distinguished, of which three were certainly imports to Brač. These are the groups of red and green radiolarites and nummulitic cherts, with a total of 12% of the weight share. They serve as unambiguous proof of the movement of the Kopačina population in the territory of present-day central Dalmatia and the region on the Adriatic eastern seaboard, probably up to central Bosnia. These three groups are present at all depths of the excavated cave sediment (less in the deeper, older layers), which speaks to the continuity of the hypothesized network of movement of the hunter-gatherers from Kopačina. While the group of nummulite cherts testifies to the link between the island and the coastal belt,

140 Whallon 1999, str. 332.
141 Whallon 1989, str. 12; Whallon 1999, str. 332.
142 Whallon 1989, str. 12; Whallon 1999, str. 337.
143 Whallon 1999, str. 339.
144 Basler 1983; Đuričić 1996; Radovanović 1986; Mihailović 1996.
145 Mihailović 1998, str. 193; Mihailović 2009, str. 76, 77, 91.
146 Mihailović 1998, str. 43.
147 Đuričić 1996, str. 95, sl. 7; Mihailović 1996, str. 57, tablica 2; Mihailović 2009, str. 31, tablica 2.
148 Đuričić 1996, str. 86.
149 Đuričić 1996; Mihailović 1996; Mihailović 2009.
150 Đuričić 1996; Mihailović 1996; Mihailović 2009.
151 Whallon 2007.

140 Whallon 1999, p. 332.
141 Whallon 1989, p. 12; 1999, p. 332.
142 Whallon 1989, p. 12; 1999, p. 337.
143 Whallon 1999, p. 339.
144 Basler 1983; Đuričić 1996; Radovanović 1986; Mihailović 1996.
145 Mihailović 1998, p. 193; Mihailović 2009, pp. 76, 77, 91.
146 Mihailović 1998, p. 43.
147 Đuričić 1996, p. 95 Fig. 7; Mihailović 1996, p. 57 Table 2; Mihailović 2009, p. 31 Table 2.
148 Đuričić 1996, p. 86.
149 Đuričić 1996; Mihailović 1996; Mihailović 2009.
150 Đuričić 1996; Mihailović 1996; Mihailović 2009.
151 Whallon 2007.

inventaru, ali indikativne vrijednosti za porijeklo sirovine, ukazuju na povezanost kopačinske populacije s dubokim zaleđem. Pokazatelje eventualnih oscilacija radijusa ili pravaca kretanja, zasad nismo zapazili u litici Kopačine. Sve tri navedene materijalne skupine nalazimo i u inventaru Vele spile, što upućuje na njihovu strukturalnu srodnost ili čak povezanost i motivira na detaljnije istraživanje te pojave. Pored skupine petrografski raznih i pojedinačno neodređenih nalaza, izdvojena je skupina žarenih nalaza s oko 10 % udjela u ukupnom inventaru, što govori u prilog trajnijeg korištenja pećine. Težinski udio bračkog metasomatskog rožnjaka iznosi oko 43 % i taj je, sudeći po nalazima jezgri i tehnološkim ostacima, najviše rabljen za izradu alatki na staništu. Pretežnost tog manje-više lokalnog rožnjaka i rožnjaka s izdanaka na prostoru do recentne obale nad udjelom radiolarita koji potječe iz daleko udaljenijih krajeva, daje zaključiti da je kopačinska populacija prebivanje na Braču i kretanje na srednjodalmatinskom prostoru preferirala u odnosu na kretanja na duge relacije.

Obrada crvenog radiolarita na staništu, počevši od faze pripreme tehnološke jezgre, potvrđena je pojedinim nalazima s valutičnom okorinom u tim skupinama, što znači da kamen nije kopan iz stijene na mjestu postanka, nego ubran na nekom alohtonom izdanku, dopremljen na stanište gdje je i obrađivan. Budući da u skupini artefakata od zelenog radiolarita nema nalaza s valutičnom okorinom, pretpostavljamo da je sirovina na stanište donošena već preparirana u tehnološke jezgre. Nalazi iz skupine rožnjaka s nodularnom, manje-više trošnom okorinom govore da nodule nisu kopane iz stijene, nego da su na ispranoj stijeni stršeće nodule rožnjaka lomljene ili da su, što je vjerojatnije, erodirane nodule i fragmenti brani u nakupinama u neposrednoj blizini stijene domaćina. Metasomatski nodularni rožnjak od kojeg su izrađivani kopačinski artefakti, može potjecati s autohtonog, odnosno s paraautohtonog izdanka na Braču, s nekog drugog otoka kao i međuotočnog prostora ili s kopnene strane Dalmacije i zaleđa. S obzirom da brojne, obilne i lako dostupne izdanke rožnjaka u bližoj i daljnjoj okolici Brača, odnosno na prostoru srednje Dalmacije, koji je kvalitetniji od nalaza u litičkom inventaru Kopačine, kopačinski lovci i sakupljači nisu iskorištavali, zaključujemo da nisu poduzimali posebne daleke pohode u potrazi i nabavi kamena, nego su sirovinske potrebe zadovoljavali na izdancima u mreži dnevnih i sezonskih kretanja u bračkom prostoru.

Usporede li se dvije osnovne vrste kamene sirovine koje čine litički inventar Kopačine (metasomatski rožnjak i radiolarit), s kulturološki, vremenski, geografski i petrografski srodnim vrstama iz Vela spile, vidljivo je da su ti inventari odraz ležišta sirovinskih stijena, odnosno srodnih tipova izdanaka vrlo rasprostranjenih u karbonatnim stijenama vanjskih Dinarida i ofiolitima unutrašnjih Dinarida. Stoga je ovaj rad podloga nastavka terenskih istraživanja na području pojavljivanja predmetnih stijena u dijelu Hrvatske, Bosne i Hercegovine i Crne Gore s ciljem geoarheološkog kartiranja izvora stijena zastupljenih u litičkim inventarima prapovijesnih nalazišta na istom prostoru. Sustavno terensko istraživanje prije svega alohtonih izdanaka takvih stijena na regionalnom i supraregionalnom prostoru, moglo bi dati konkretnije i preciznije odgovore na pitanja mogućeg i vjerojatnog porijekla kamena predmetnih artefakata, a time i povezanosti navedenih epigravetijenskih nalazišta.[152]

the group of green and red radiolarites, with a small share in the lithic inventory, but with an indicative value for the origin of the raw materials, point to the ties between the Kopačina population with the deep hinterland. Indicators of potential oscillations between the radius and direction of movement have thus far not been noted in the Kopačina lithics. All three of the aforementioned material groups can be found in the inventory of Vela Spila, which indicates their structural similarity or even a link, and serves as an impetus for further research into this phenomenon. Besides the group of petrographically different and individually indeterminate finds, a group of fired finds, with a 10% share in the overall inventory, has also been distinguished, which speaks in favour of the more permanent use of the cave. The weight share of Brač metasomatic cherts is roughly 43%, and this, judging by the core finds and technological remains, was mostly used to craft finds in the habitat. The predominance of this more or less local chert and cherts from outcrops in the area up to the recent coastline over the share of radiolarites which come from more distant regions leads to the conclusion that the Kopačina population preferred to reside on Brač and move about in the central Dalmatian zone as opposed to movement over longer distances.

The retouching of red radiolarites at the site, beginning with the preparatory phase for technological cores, has been confirmed in individual finds with rinds of pebbles in these groups, which means that the rocks were not dug out from their place of origin, but rather gathered at some allochthonous outcrop, transported to the habitat and then processed. Since the group of artefacts made of green radiolarites contains no finds with a rind of pebbles, we assume that the raw materials at the habitat were brought already prepared into technological cores. The finds from the group of cherts with nodular, more or less weathered cortex indicates that the nodules were not extracted from a rock face, but rather jutting nodules of chert were broken off, or more likely, eroded nodules and fragments were gathered in accretions in the immediate vicinity of the host rock. The metasomatic nodular chert used to make the Kopačina artefacts may have originated from autochthonous, or para-autochthonous outcrops on Brač, some other island, and in the inter-insular area or on the mainland side of Dalmatia and its hinterland. Given that the Kopačina hunter-gatherers did not use the numerous, abundant and easily accessible outcrops of chert in the nearer and more distant vicinity of Brač, i.e., in the territory of central Dalmatia, which are of a higher quality than the finds in the lithic inventory of Kopačina, we have concluded that they did not undertake forays to specifically search for stone to procure, rather they met their need for raw materials at outcrops inside the network of their daily and seasonal movement in the Brač area.

If the two basic types of stone raw materials which form the lithic inventory of Kopačina (metasomatic chert and radiolarite) are compared with the culturally, chronologically, geographically and petrographically similar Vela Spila, it is apparent that these inventory finds are a reflection of the deposits of the source rocks, i.e. similar types of outcrops very widespread in the carbonate rocks of the external Dinaric zone and the ophiolites inside the Dinaric zone. Therefore, this work serves as the basis for the continuation of research into the territory in which these rocks appear in parts of Croatia, Bosnia and Herzegovina and Montenegro, with the objective of geoarchaeological mapping of the sources of the rocks present in the lithic inventories of the prehistoric sites in the same area. Systematic field research into above all allochthonous outcrops of such rock in the regional and supra-regional zone may provide more specific and precise answers to the question of the potential and probable origin of the stone in these artefacts, and thereby also the links between these Epigravettian sites.[152]

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Dubina (cm)	0-20 (N=67)	20-40 (N=124)	40-60 (N=117)	60-80 (N=87)	80-100 (N=83)	100-120 (N=82)	120-140 (N=96)	140-160 (N=136)	160-180 (N=135)	180-200 (N=155)	200-220 (N=44)	220-240 (N=9)	240-260 (N=30)	260-280 (N=16)	280-300 (N=14)
Tip	%	%	%	%	%	%	%	%	%	%	%	%	%	%	%
noktoliko grebalo	13,43	29,84	17,09	12,64	14,46	17,07	20,83	8,09	14,07	9,03	13,64	33,33	13,33	12,50	0,00
kružno grebalo	0,00	0,00	1,71	0,00	0,00	1,22	4,17	2,94	0,00	0,00	0,00	0,00	0,00	0,00	0,00
grebalo na odbojku	22,39	12,10	12,82	11,49	19,28	17,07	14,58	10,29	12,59	9,03	15,91	0,00	13,33	0,00	7,14
grebalo na sječivu/pločici	0,00	2,42	1,71	3,45	1,20	2,44	0,00	0,00	1,48	1,29	2,27	0,00	6,67	0,00	0,00
pločica s hrptom	0,00	2,42	2,56	1,15	1,20	0,00	6,25	0,00	0,74	0,65	0,00	0,00	0,00	6,25	0,00
šiljak s hrptom	1,49	0,00	0,85	0,00	0,00	6,10	0,00	4,41	2,22	6,45	0,00	11,11	0,00	12,50	0,00
mikrograveta	0,00	0,00	0,00	0,00	0,00	0,00	1,04	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00
gravetijenski šiljak	0,00	0,00	0,00	0,00	0,00	0,00	0,00	1,47	0,00	0,00	0,00	0,00	0,00	0,00	0,00
segment	0,00	0,81	0,00	0,00	0,00	0,00	0,00	0,00	0,74	0,00	0,00	0,00	0,00	0,00	0,00
pravokutnik	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00
zarubak	0,00	1,61	0,85	0,00	2,41	0,00	4,17	2,21	0,00	2,58	2,27	0,00	3,33	6,25	0,00
strugalo	8,96	11,29	9,40	12,64	15,66	6,10	7,29	15,44	6,67	16,77	4,55	0,00	13,33	18,75	14,29
svrdlo	1,49	0,81	1,71	0,00	1,20	1,22	2,08	2,21	0,74	5,16	0,00	0,00	0,00	0,00	14,29
dubilo	2,99	1,61	3,42	1,15	1,20	1,22	0,00	1,47	2,22	1,94	13,64	0,00	10,00	0,00	28,57
iskrzani komad	8,96	4,84	7,69	8,05	8,43	6,10	11,46	7,35	11,85	10,32	4,55	11,11	10,00	0,00	0,00
komad sa sitnom rubnom obradom	4,48	2,42	1,71	2,30	2,41	1,22	2,08	2,21	2,22	0,65	4,55	0,00	3,33	0,00	14,29
komad s obradom	17,91	13,71	17,95	28,74	18,07	25,61	18,75	18,38	20,74	18,71	20,45	44,44	20,00	18,75	14,29
nazubak	14,93	13,71	17,09	9,20	13,25	14,63	7,29	16,18	14,81	14,84	18,18	0,00	6,67	18,75	7,14
udubak	2,99	2,42	1,71	5,75	1,20	0,00	0,00	2,94	5,19	2,58	0,00	0,00	0,00	6,25	0,00
obrađeni ulomak	0,00	0,00	1,71	3,45	0,00	0,00	0,00	4,41	3,70	0,00	0,00	0,00	0,00	0,00	0,00
ukupno	100,00	100,00	100,00	100,00	100,00	100,00	100,00	100,00	100,00	100,00	100,00	100,00	100,00	100,00	100,00

Depth (cm)	0-20 (N=67)	20-40 (N=124)	40-60 (N=117)	60-80 (N=87)	80-100 (N=83)	100-120 (N=82)	120-140 (N=96)	140-160 (N=136)	160-180 (N=135)	180-200 (N=155)	200-220 (N=44)	220-240 (N=9)	240-260 (N=30)	260-280 (N=16)	280-300 (N=14)
Type	%	%	%	%	%	%	%	%	%	%	%	%	%	%	%
thumbnail endscraper	13.43	29.84	17.09	12.64	14.46	17.07	20.83	8.09	14.07	9.03	13.64	33.33	13.33	12.50	0.00
circular endscraper	0.00	0.00	1.71	0.00	0.00	1.22	4.17	2.94	0.00	0.00	0.00	0.00	0.00	0.00	0.00
endscraper on flake	22.39	12.10	12.82	11.49	19.28	17.07	14.58	10.29	12.59	9.03	15.91	0.00	13.33	0.00	7.14
endscraper on blade/ bladelet	0.00	2.42	1.71	3.45	1.20	2.44	0.00	0.00	1.48	1.29	2.27	0.00	6.67	0.00	0.00
backed bladelet	0.00	2.42	2.56	1.15	1.20	0.00	6.25	0.00	0.74	0.65	0.00	0.00	0.00	6.25	0.00
curved backed point	1.49	0.00	0.85	0.00	0.00	6.10	0.00	4.41	2.22	6.45	0.00	11.11	0.00	12.50	0.00
micro-Gravette	0.00	0.00	0.00	0.00	0.00	0.00	1.04	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Gravettian point	0.00	0.00	0.00	0.00	0.00	0.00	0.00	1.47	0.00	0.00	0.00	0.00	0.00	0.00	0.00
segment	0.00	0.81	0.00	0.00	0.00	0.00	0.00	0.00	0.74	0.00	0.00	0.00	0.00	0.00	0.00
rectangle	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
truncation	0.00	1.61	0.85	0.00	2.41	0.00	4.17	2.21	0.00	2.58	2.27	0.00	3.33	6.25	0.00
sidescraper	8.96	11.29	9.40	12.64	15.66	6.10	7.29	15.44	6.67	16.77	4.55	0.00	13.33	18.75	14.29
borer	1.49	0.81	1.71	0.00	1.20	1.22	2.08	2.21	0.74	5.16	0.00	0.00	0.00	0.00	14.29
burin	2.99	1.61	3.42	1.15	1.20	1.22	0.00	1.47	2.22	1.94	13.64	0.00	10.00	0.00	28.57
splintered piece	8.96	4.84	7.69	8.05	8.43	6.10	11.46	7.35	11.85	10.32	4.55	11.11	10.00	0.00	0.00
marginally retouched piece	4.48	2.42	1.71	2.30	2.41	1.22	2.08	2.21	2.22	0.65	4.55	0.00	3.33	0.00	14.29
retouched piece	17.91	13.71	17.95	28.74	18.07	25.61	18.75	18.38	20.74	18.71	20.45	44.44	20.00	18.75	14.29
denticulate	14.93	13.71	17.09	9.20	13.25	14.63	7.29	16.18	14.81	14.84	18.18	0.00	6.67	18.75	7.14
notch	2.99	2.42	1.71	5.75	1.20	0.00	0.00	2.94	5.19	2.58	0.00	0.00	0.00	6.25	0.00
retouched fragment	0.00	0.00	1.71	3.45	0.00	0.00	0.00	4.41	3.70	0.00	0.00	0.00	0.00	0.00	0.00
total	100.00	100.00	100.00	100.00	100.00	100.00	100.00	100.00	100.00	100.00	100.00	100.00	100.00	100.00	100.00

Dodatak 1.
Relativna učestalost različitih tipova alatki po dubinama, uzimajući u obzir samo vrećice s rasponom dubina od 20 cm, od 0 do 300 cm.

Appendix 1.
Relative frequency of different types of tools by depth, taking into consideration only the bags with depth increments of 20 cm, from 0 to 300 cm.

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