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NEOLITHIC FLAKED STONE INDUSTRIES OF THE EASTERN ADRIATIC: THE ASSEMBLAGES FROM PUPIĆINA AND GRAPČEVA CAVES

RIASSUNTO – *Le industrie neolitiche su selce scheggiata dell'Adriatico orientale: i complessi provenienti dalle caverne di Pupićina e Grapčeva.* Nella prima parte del lavoro vengono descritte ed analizzate le industrie litiche di due caverne con depositi stratificati di età preistorica: Pupićina, in Istria, e Grapčeva, in Dalmazia. Entrambi i complessi litici sono stati raccolti in modo sistematico durante le ricerche condotte recentemente. La discussione riguarda il materiale impiegato, la tecnica di produzione, i moduli di riduzione e scarto degli strumenti e delle schegge di lavorazione. Sulla base di questi dati, si propongono nuove osservazioni circa le industrie litiche postmesolitiche della regione. Tra queste: il problema dell'introduzione della tecnologia della produzione laminare a sezione prismatica, le variazioni nell'economia di produzione e nella tecnologia durante il Neolitico e le altre epoche, ed il periodo in cui la produzione di oggetti litici venne a cessare.

ABSTRACT – *Neolithic flaked stone industries of the eastern Adriatic: the assemblages from Pupićina and Grapčeva Caves.* The first part of this paper describes and analyses lithic assemblages from two stratified prehistoric cave sites: Pupićina (in Istria) and Grapčeva (in Dalmatia). Both assemblages were systematically recovered during recent excavations. Discussion touches upon raw material procurement, production technology, reduction strategy and discard of tools and waste, as well as temporal trends observed in the data. Departing from this new information and drawing on reports from other contemporaneous sites in the eastern Adriatic, I address several open issues of post-Mesolithic lithic industries in the region: the introduction of prismatic blade technology, the change in lithic economy and technology during Neolithic and later periods, and the timing of cessation of lithic production.

INTRODUCTION

Ever since late 19th century, explorers of eastern Adriatic prehistory have been sporadically reporting artefacts made of flaked stone (e.g. BUCCICH, 1885). Until very recently, however, the field of lithic analysis in the region was completely overshadowed by pottery studies, primarily stylistic analyses carried out in order to build chronological sequences and discern origins, relationships and connections (true or imagined) of various archaeological cultures. In the meantime, the ubiquitous flaked stone artefacts were neglected, and virtually no attempt was made to deal with them in a systematic and extensive way. Haphazard collection, problematic description and casual reporting were the rule. As a consequence, little can be said today about post-Mesolithic flaked stone industries of the region with any degree of certainty.

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This paper aims to improve this unsatisfactory situation in two ways. Its first part presents lithic assemblages from two recently excavated caves: Pupićina (in Istria) and Grapčeva (on the island of Hvar in Dalmatia) which, unlike almost all other lithic collections form the region, were recovered by procedures that meet current professional standards. Both excavations followed natural stratigraphy, and all excavated sediments were sieved (using 3-mm mesh in Pupićina, 6-mm mesh in Grapčeva), ensuring systematic recovery of artefacts. The resulting assemblages come fully equipped with information about stratigraphy, associated pottery and other classes of archaeological materials, as well as radiocarbon dates. This means that they can be safely compared, and issues such as raw material procurement, production technology, reduction strategy and discard of tools and waste, as well as various temporal trends, can be meaningfully addressed.

The second part of this paper discusses a number of general questions regarding post-Mesolithic flaked stone industries of the eastern Adriatic. It is important to bear in mind that any such discussion will be severely limited by the imperfect character of the currently available data, since old reports are often incomplete, unreliable or even inadequate. One may discuss such data after reviewing it critically and carefully, or relegate the discussion to some better time in the future. While choosing the second option may be safer, I still consider the first to be more useful.

The starting points of my discussion are the two systematically recovered (if quite small) assemblages from Pupićina and Grapčeva, but I also include a variety of information carefully gleaned from excavation reports of other sites. I offer this discussion primarily as a stimulus for future research in a region where lithic analysis has been sadly neglected. It goes without saying that any tentative conclusions reached in this paper must not be taken as final statements, but should be regarded as provisional, with plenty of space for improvement.

A brief note on chronology is due, in order to make the ensuing presentation and discussion easier to follow. Traditionally, the Eastern Adriatic Neolithic has been divided into three phases, based on characteristic pottery styles (e.g. Batović, 1979). These styles can now be roughly dated by radiocarbon (Forenbaher and Kaiser, 1999; Forenbaher *et al.*, 2004). The Early Neolithic, characterized by Impressed Wares, covers the first half of the 6th millennium CAL BC.

The Middle Neolithic, characterized by pottery with incised geometric designs (including spirals), known as "Danilo style" in Dalmatia and "Vlaška style" farther up north, covers the second half of the 6th millennium CAL BC. The Late Neolithic, characterized by geometric decoration painted bright red after firing, known as "Hvar style", covers most of the 5th millennium CAL BC. A rather ill-defined Copper Age follows, with an earlier phase sometimes known as "Nakovana" probably covering much of the 4th millennium CAL BC, and a later phase characterized by "Cetina style" pottery, which apparently covers much of the 3rd millennium CAL BC and continues into the Early Bronze Age (e.g. Dimitrijević, 1979; Marović and Čović, 1983; Marijanović, 1992; Forenbaher, 2000). Many details of chronology remain open (the timing of particular Middle Neolithic polychrome pottery styles, duration of the "Nakovana style", chronological position of different varieties of "Cetina style", etc.), but their discussion lies beyond the scope of this paper.

FLAKED STONE ASSEMBLAGE FROM PUPIĆINA CAVE

Pupićina Cave is a stratified prehistoric site, located in the interior of northeastern Istria (Croatia). Extensive excavation[1], carried out between 1995 and 2002, demonstrated that the site was occupied (with breaks) from the Late Upper Paleolithic until Roman Imperial times. Its post-Mesolithic chronostratigraphic sequence consists of nine stratigraphic horizons. The earliest two Horizons (I and H) belong to the Middle Neolithic (characterized by Danilo-Vlaška pottery) and roughly cover the second half of the 6th millennium CAL BC. The following, Middle Neolithic Horizon G (which contains some "Hvar-like" pottery), belongs to the fifth millennium CAL BC. Copper age levels were not encountered in the excavated parts of the site. Instead, directly overlying the Neolithic levels are the Middle to Late Bronze Age Horizons F, E and D, which date to around the middle of the second millennium CAL BC. Above them are Iron Age Horizons (C and B) and a mixed surface horizon A that contains some Roman finds. A residual category of mixed/disturbed deposits is designated as Horizon X. Middle Neolithic (Danilo/Vlaška) and Middle Bronze Age occupations are particularly well documented, while Late Neolithic, Iron Age and Roman remains are less abundant. Further information about site location, morphology, research history, radiocarbon dating, and pottery sequence is available in a recent publication (FORENBAHER *et al.*, 2004), while various other aspects of the site's post-Mesolithic archaeology are discussed in MIRACLE and FORENBAHER (in press).

Numerous lithic artefacts were recovered from Mesolithic and earlier layers of Pupićina Cave, but we do not discuss those assemblages at this occasion. We concentrate instead on lithic finds from post-Mesolithic levels of the site, which yielded a total of 123 flaked stone artefacts, weighing approximately 250 grams.

RAW MATERIALS

Physical characteristics of raw material were recorded for all artefacts, based on macroscopic visual examination aided by a hand lens (magnification 10 x). Colour was recorded with the aid of Munsell Soil Color Charts, including cortex colour of all cortical elements. Finds were classified by translucency into three arbitrary ordered categories (opaque, cloudy, clear). Shape, distribution and colour of inclusions were noted, where present. Indicators of exposure to heat such as crazing, potlids or differential luster were recorded. Particular attention was paid to differential luster within flake scars as an indicator of heat alteration (COLLINS and FENWICK, 1974: 137), or along working edges as an indicator of use-wear (SEMENOV, 1964: 113-122). Mineralogical analysis aimed at sourcing the raw materials was not attempted at this stage, since the region still lacks systematic geological survey data about sources of chert and flint.

A single small piece of black, translucent obsidian was recovered. This material undoubtedly is exotic, since there are no sources of obsidian within the wider region. Most of the

[1] This excavation was carried out as a part of the "Pupićina Cave Project", a joint venture of the University of Cambridge (UK) and the Archaeological Museum of Istria, Pula (Croatia).

relatively few obsidian pieces from north-eastern Adriatic littoral that have been sourced came from Lipari, while only a few came form Palmarola and Carpathian sources (TYKOT, 1996: fig. 10). The piece from Pupićina Cave has been identified as Liparan obsidian (TYKOT, pers. comm. 2004).

All other flaked stone artefacts were made of a variety of fine-grained cryptocrystalline silica rocks with good flaking characteristics (regular conchoidal fracture), which here will be labeled as 'cherts' (LUEDTKE, 1992: 5 and 6). Fourteen of them were burned, and these were excluded from raw material analyses, since their characteristics were obviously altered by the heat. Nine pieces have unusually high overall luster, while only three pieces exhibit differential luster, possibly indicating intentional heat treatment.

Class	N	N %	Weight (g)	Weight %
obsidian	1	0.8	0.3	0.1
dark chert	44	35.8	93.7	37.2
reddish chert	9	7.3	14.6	5.8
brown chert	12	9.8	31.4	12.5
pale chert	43	35	80.3	31.9
indeterminate	14	11.4	31.4	12.5
Total	123	100	251.7	100

Table 1 - Pupićina Cave: frequency of raw material classes.

Four major classes of chert were recognized (table 1). The most common class is 'dark cherts' which range in colour from grey to black, sometimes with a brownish or greenish tinge. They are opaque or, in a few instances, cloudy-translucent (less than 7%). Less than a quarter of these cherts are speckled, mottled or banded, containing white or (less frequently) grey, red or olive brown inclusions. Their cortex can be almost of any colour, from black to grey, brown, yellow, red or white. 'Pale cherts' are almost just as common, ranging in colour from light grey to pale brown, pale yellow and white. More than half of these are translucent (51% cloudy, 7% clear), and over two thirds (70%) are white-speckled. Their cortex is pale yellow or white. 'Brown cherts' are less common, ranging in colour from brown to dark brown and greyish brown. The majority is translucent (50% cloudy, 20% clear), and most are white-speckled (77%). Like previous class, their cortex is also pale yellow or white. 'Reddish cherts' represent the least common class, ranging in colour from red to dark reddish brown. All but one are opaque, and one out of three is speckled or mottled. Their cortex is dark reddish. Burned pieces were classified as 'indeterminate'.

There are a number of physical similarities between 'pale' and 'brown' cherts: their translucency, white specks and pale-coloured cortex. Likewise, there are physical similarities between 'dark' and 'reddish' cherts: their opacity, as well as relative scarcity and diversity of inclusions. The assemblage is split almost exactly in half between 'pale and brown' and 'dark and red' cherts.

Additional similarities come to light if one investigates the relationship between morphological characteristics of flaked stone artefacts and the raw material, which they were made of. The two most contrasting groups are artefacts made of the two most common classes of raw material - the 'dark cherts' and the 'pale cherts'. Of the other two classes, artefacts made of 'brown cherts' are usually more similar to those made of 'pale cherts', while artefacts made of 'reddish cherts' are more similar to those made of 'dark cherts'.

Artefacts made of 'pale cherts' are generally larger, more elongated and thinner than those made of 'dark cherts' (table 2; fig. 1). Differences in average size of artefacts probably reflect differences in size of the respective raw material packages. While the site itself has not yielded any chert nodules or cores in early stages of reduction, which would hint at that size, non-systematic survey shows that 'dark cherts' are locally available in small packages. As opposed to that, we know nothing about sources or package sizes of 'pale cherts'.

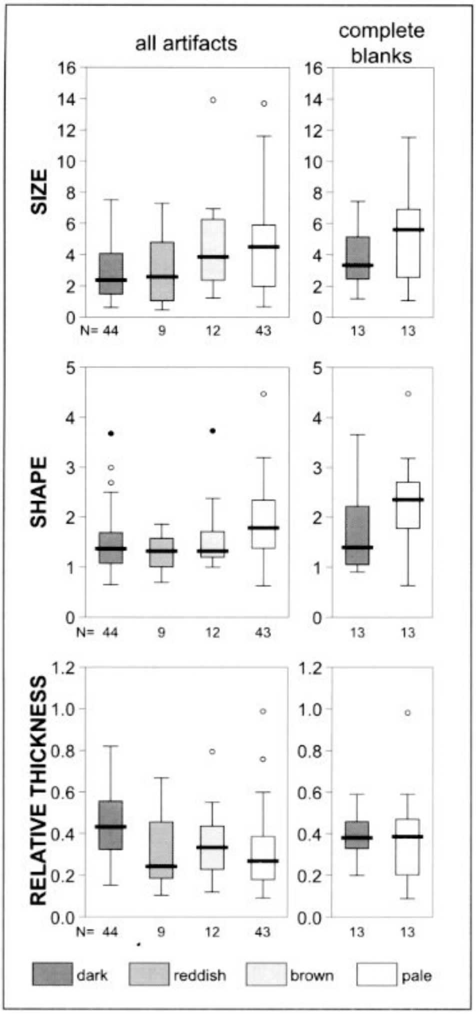

Fig. 1 - Pupićina Cave. Boxplots for size (length x width), shape (length/width), and relative thickness (thickness/width) of artefacts by raw material class. Calculated for all artefacts (left) and complete blanks only (right).

SIZE = length x width					
Raw material	Average	Sd	Min	Max	N
dark chert	2.9	1.99	0.57	7.5	44
reddish chert	3.05	2.42	0.47	7.25	9
brown chert	4.64	3.46	1.19	13.8	12
pale chert	4.39	3.04	0.67	13.58	43
SHAPE = length / width					
Raw material	Average	Sd	Min	Max	N
dark chert	1.49	0.59	0.64	3.67	44
reddish chert	1.33	0.39	0.71	1.87	9
brown chert	1.58	0.77	0.97	3.72	12
pale chert	1.93	0.76	0.62	4.45	43
RELATIVE THICKNESS = thickness / width					
Raw material	Average	Sd	Min	Max	N
dark chert	0.46	0.17	0.16	0.82	44
reddish chert	0.33	0.19	0.11	0.67	9
brown chert	0.35	0.19	0.12	0.79	12
pale chert	0.31	0.18	0.09	0.98	43

Table 2 - Pupićina Cave: descriptive statistics for artefact size, shape and relative thickness by raw material class.

The fact that the artefacts made of 'pale cherts' are generally more elongated and thinner than those made of 'dark cherts' reflects employment of different reduction strategies for different classes of raw material. 'Pale cherts' were preferred for production of prismatic blades, while 'dark cherts' were used more expediently for production of a variety of flake-base tools. This becomes evident when different classes of blanks are compared (table 3; fig. 2). 'Dark cherts' make up over a third of all flakes, less than a third of all bladelets, and only 4% of all blades. Two thirds of all blades were made of 'pale cherts' - in fact, blades were made almost exclusively of 'pale cherts' or 'brown cherts'. Unsurprisingly, most blade-based tools (retouched blades, backed blades and geometrics) were also made of these two classes of raw material, while half of all flake-based tools (various scrapers, denticulates, retouched Distribution of raw material classes across main formal classes of artefacts also shows some interesting trends (table 4; fig. 3). While similar fractions of each raw material class were made into tools, 'dark' and 'reddish' cherts appear most commonly as debris (48% and 67% respectively), while 'pale chert' and 'brown chert' debris is relatively scarce (under 20% in both cases). As opposed to that, *débitage* made of 'pale chert' and 'brown chert' is relatively plentiful, while 'dark' and 'reddish' *débitage* is scarce. It is important to note that much of the 'pale chert' and 'brown chert' *débitage* consists of blades, and therefore cannot be considered as functional 'waste'. Furthermore, cortical elements, although generally not common,

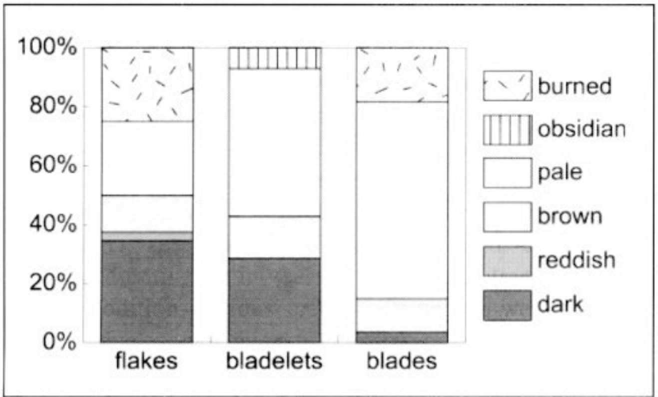

Fig. 2 - Pupićina Cave. Relative frequency of raw material class by blank shape.

Raw material	flakes	bladelets	blades
obsidian		1	
dark chert	11	4	1
reddish chert	1		
brown chert	4	2	3
pale chert	8	7	18
indeterminate	8		5
Total	32	13	27

Table 3 - Pupićina Cave: blank shapes by raw material class.

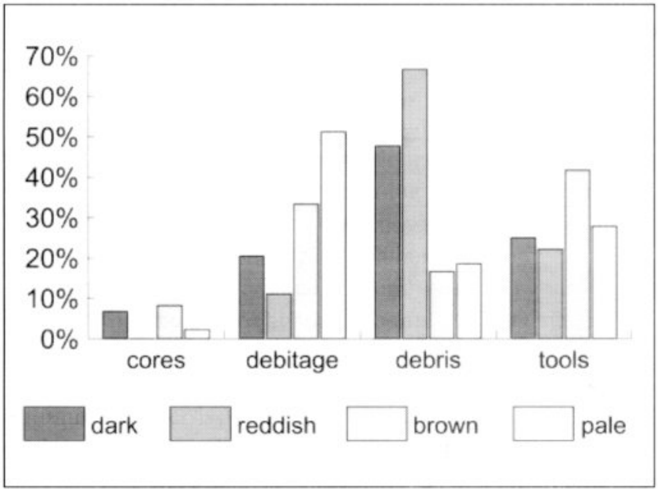

Fig. 3 - Pupićina Cave. Relative frequency of raw material class by major artifact classes.

Class	cores		débitage		debris		tools		Total
obsidian							1	100.0%	1
dark chert	3	6.8%	9	20.5%	21	47.7%	11	25.0%	44
reddish chert			1	11.1%	6	66.7%	2	22.2%	9
brown chert	1	8.3%	4	33.3%	2	16.7%	5	41.7%	12
pale chert	1	2.3%	22	51.2%	8	18.6%	12	27.9%	43
indeterminate			8	57.1%	1	7.1%	5	35.8%	14
Total	5	4.1%	44	35.8%	38	30.9%	36	29.3%	123

Table 4 - Pupićina Cave: tools, cores, *débitage* and debris by raw material class.

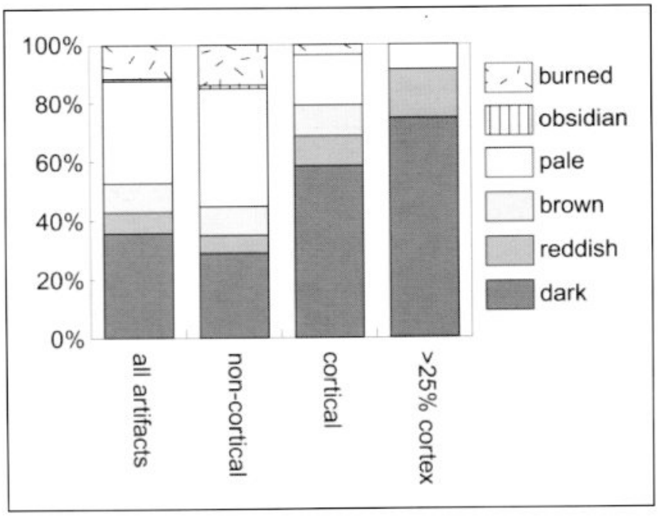

Fig. 4 - Pupićina Cave. Relative frequency of raw material class by cortical elements.

Raw material	all artefacts	non-cortical	cortical	>25% cortex
obsidian	1	1		
dark chert	44	27	17	9
reddish chert	9	6	3	2
brown chert	12	9	3	
pale chert	43	38	5	1
indeterminate	14	13	1	
Total	123	94	29	12

Table 5 - Pupićina Cave: cortical elements by raw material class.

are more frequent among 'dark cherts' and 'reddish cherts' than among 'pale cherts' and 'brown cherts' (table 5; fig. 4).

All this suggests that 'dark cherts' and 'reddish cherts' were acquired locally, and that at least a part of their reduction was carried out at the site itself. They were used primarily for production of expedient, flake-based tools. In contrast to that, 'pale cherts' and 'brown cherts' were acquired from unknown (probably, non-local) sources and used primarily for production of prismatic blades and blade-based tools. Most of those blades and tools were introduced to the site in their final or nearly final form.

ASSEMBLAGE BREAK-DOWN BY TECHNOLOGICAL CLASS

Almost 70% of all flaked stone artefacts came from the Middle Neolithic Horizons H and I (table 6). Another 12% came from the Late Neolithic Horizon G. All Bronze and Iron Age horizons combined yielded just 10% of all artefacts, most of it *débitage* and debris. The remaining 8% comes from the Roman and mixed surface Horizon A, or from unknown or insecure contexts. More importantly, weight density of lithics (relative weight of finds per cubic meter of excavated soil) exhibits the same continuously decreasing trend (table 7). This strongly suggests that all or virtually all flaked stone artefacts belong to the Neolithic, and that flaked stone tools were no longer used in Pupićina Cave during the Middle Bronze Age and later periods, or were used only exceptionally.

Taken as a whole, the assemblage contains a very high percentage of tools (almost a third). *Débitage* is the most copious category, constituting slightly over another third of all artefacts. Cores are relatively scarce, and debris makes up the remaining 31% of the assemblage (table 8).

Constituting 31% of the assemblage by artifact number, or 20% by weight, debris is not considered as plentiful at Pupićina Cave. Most of it comes as chips (pieces of flaked stone smaller than 15 mm, except bladelet segments and tools), plus a few relatively small chunks (unclassifiable pieces of broken chert larger than 15 mm).

					all flaked stone artefacts			
Horizon	cores	*débitage*	debris	tools	N		weight	
A	1			2	3	*2.4%*	7.1	*2.8%*
B			4		4	*3.3%*	1	*0.4%*
E		2	2		4	*3.3%*	3.9	*1.5%*
F		3		1	4	*3.3%*	5.6	*2.2%*
G	1	4	2	8	15	*12.2%*	20.6	*8.2%*
H		23	11	12	46	*37.4%*	115.6	*45.9%*
I	3	10	18	9	40	*32.5%*	85.3	*33.9%*
X		2	1	4	7	*5.7%*	12.6	*5.0%*
Total	5	44	38	36	123	*100.0%*	251.7	*100.0%*

Table 6 - Pupićina Cave: flaked stone artefacts by horizon.

Horizon	volume (m^3)	weight (g)	density (g/m^3)
A	4.061	7.1	1.7
B+C	4.273	1	0.2
D	0.132	0	0
E	0.684	3.9	5.7
F	0.654	5.6	8.6
G	1.862	20.6	11.1
H	7.246	115.6	16.0
I	3.812	85.3	22.4
X	1.265	12.6	10.0
Total	23.816	251.7	10.6

Table 7 - Pupićina Cave: weight density of flaked stone artefacts by stratigraphic horizon.

Class	Count		Weight	
Tools	36	*29.3%*	86.2	*34.2%*
retouched blades and bladelets	8		16.8	
geometrics	4		5.8	
backed bladelet	1		0.3	
scrapers	10		20	
retouched flakes	3		14.9	
denticulates	2		14.2	
broken retouched pieces	3		5.2	
scaled pieces	3		5.4	
bifacial arrow points	2		3.6	
Waste (cores, debitage and debris)	87	*70.7%*	165.5	*65.8%*
Cores	5	*4.1%*	16.7	*6.6%*
Débitage	44	*35.8%*	98	*38.9%*
blades and bladelets	24		47.9	
flakes	20		50.1	
Debris	38	*30.9%*	50.8	*20.2%*
chips	32		15.2	
chunks	6		35.6	
Total	123	*100.0%*	251.7	*100.0%*

Table 8 - Pupićina Cave: total assemblage breakdown.

Only five artefacts (4% of the total assemblage) were classified as cores or core fragments. All are fairly small and irregular or amorphous. They will be described in more detail below, in sections discussing assemblages from particular occupation phases. It should be added here that two overshot blades, which removed substantial parts of prismatic blade cores, testify that such cores also were present and reduced at the site.

Débitage is the most copious category of flaked stone artefacts, which constitutes more than a third of the total assemblage. The blade index is very high; more than a half of all *débitage* are blades and bladelets.

Flakes are rather small, most of the complete examples being between 15 and 40 mm long, and weighing only a few grams. There is little evidence of platform preparation. Flat platforms predominate, although cortical, complex (dihedral or faceted) and crushed platforms (ANDREFSKY, 1998: 92-96) are commonly present. Bulbs of percussion are often relatively large and prominent. Flakes were made of all classes of raw material, in almost exactly the same proportion in which those materials appear in the total assemblage: a third of all flakes (including those that were used as blanks for tools) were made of 'dark cherts', a quarter of 'pale cherts', a few of 'brown cherts' and a only one of 'reddish cherts' (table 3; fig. 2). This suggests that all of the available raw materials were considered as equally suitable for flake production.

All elongated pieces of *débitage*, which are more than twice as long as they are wide, were classified as blades or bladelets. They were classified according to their size, and also according to their overall morphology (regularity of outline shape and dorsal scar pattern). Blades/bladelets are small or medium-size, from 15 to 60 mm long, and from 6 to 22 mm wide. Their width distribution (fig. 5) suggests that two size-groups are present, with a break point around the width of 11 mm. Furthermore, scatterplot of length to width for all complete examples (fig. 6) shows two clusters: a group of smaller 'bladelets' (less than 11 mm wide and 30 mm long) and a group of larger 'blades' (more than 11 mm wide and 30 mm long). This simple criterion is a slight modification of the one proposed by TIXIER (1963), which seems better suited for the particular assemblage under investigation. It has been applied consistently to differentiate between the two classes of elongated *débitage*.

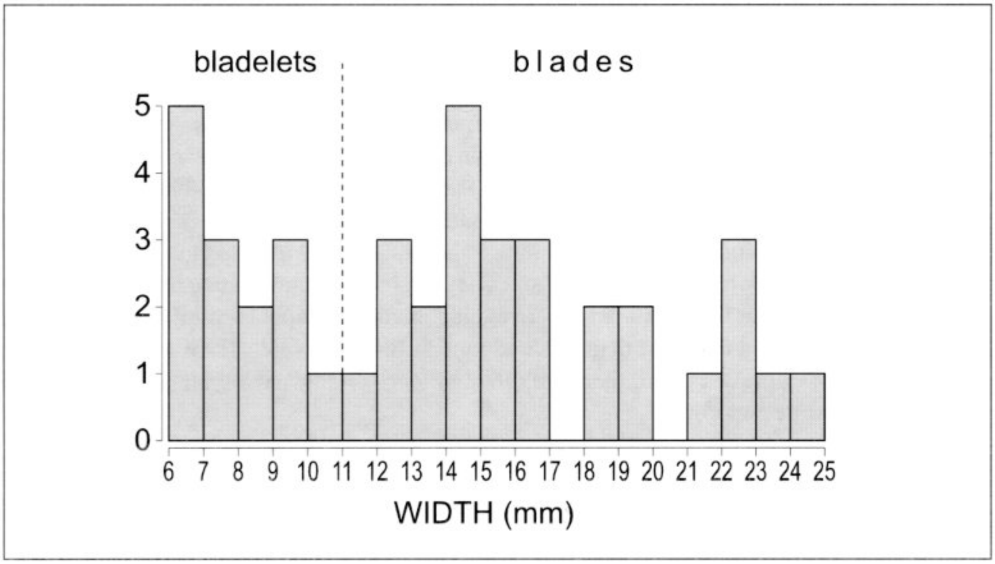

Fig. 5 - Pupićina Cave. Histogram of blade/bladelet width.

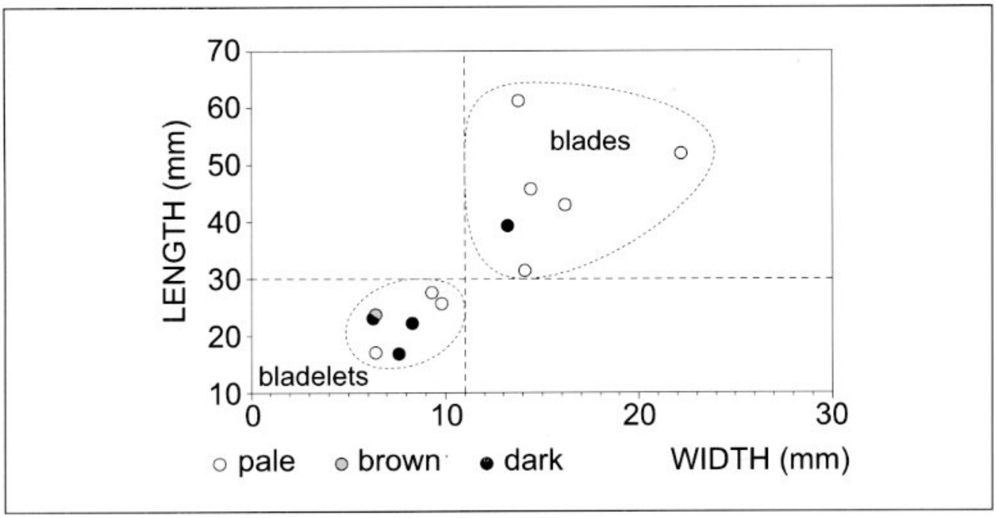

Fig. 6 - Pupićina Cave. Scatterplot of length and width for all complete blades and bladelets, coded by raw material class (pale, brown or dark chert).

Thus defined, bladelets are less numerous (one out of three). Their outline and dorsal scar pattern is usually irregular (fig. 7, nn. 11 and 12). Half of them have flat percussion platforms, while the remaining have crushed or (rarely) complex platforms (ANDREFSKY, 1998: 92-96). There is little evidence of platform preparation. Bulbs of percussion tend to be small but are often prominent. About 30% of them are made of 'dark cherts', while the rest are made of 'pale cherts', 'brown cherts' or obsidian. Blades are more numerous (two out of three). Most of them are regularly shaped prismatic blades, with parallel lateral edges and dorsal scars (fig. 7, n. 14 and 9, n. 7). Two thirds of them have flat percussion platforms, while the remaining have complex or (rarely) crushed platforms (ANDREFSKY, 1998: 92-96). Again, there is little evidence of platform preparation. Bulbs of percussion tend to be small and diffuse. Almost all of them are made of 'pale cherts' or 'brown cherts'.

Similarly, one can investigate correlations between shapes of blades/bladelets (regardless of their size) and major chert classes. 'Prismatic' blades/bladelets are those with parallel or sub-parallel edges and ridges between removal scars, usually of triangular or trapezoidal or - less commonly - polygonal cross-section. They are more common (two out of three), and are almost never made of 'dark cherts'. 'Irregular' blades/bladelets are all other pieces of elongated *débitage* that are more than twice as long as they are wide. They are less common (one out of three), almost 30% of them are made of 'dark cherts', while the rest are made of 'pale cherts' and 'brown cherts'.

This evidence suggests possible presence of two different blade technologies. One, less well documented, used small packages of locally available 'dark cherts' for production of small, irregular bladelets (or, alternatively, bladelets made of 'dark cherts' were an accidental by-product of a flake-based production technology). The other, much better documented reduction strategy, used larger packages of (probably) non-local 'pale cherts' and 'brown cherts', and was primarily aimed at production of larger, prismatic blades.

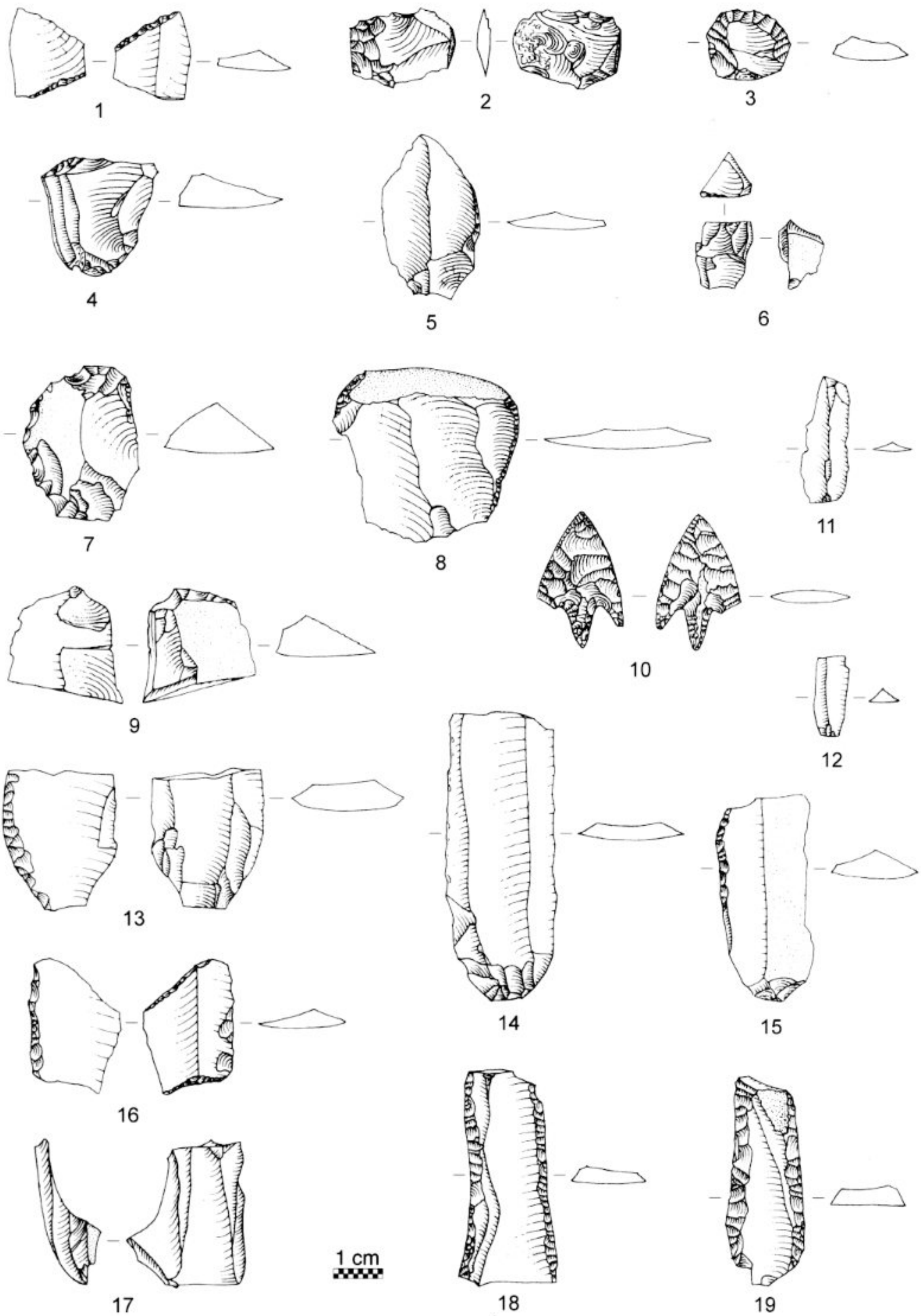

Fig. 7 - Pupićina Cave. A selection of flaked stone artefacts. 1-6 Horizon I; 7-19: Horizon H.

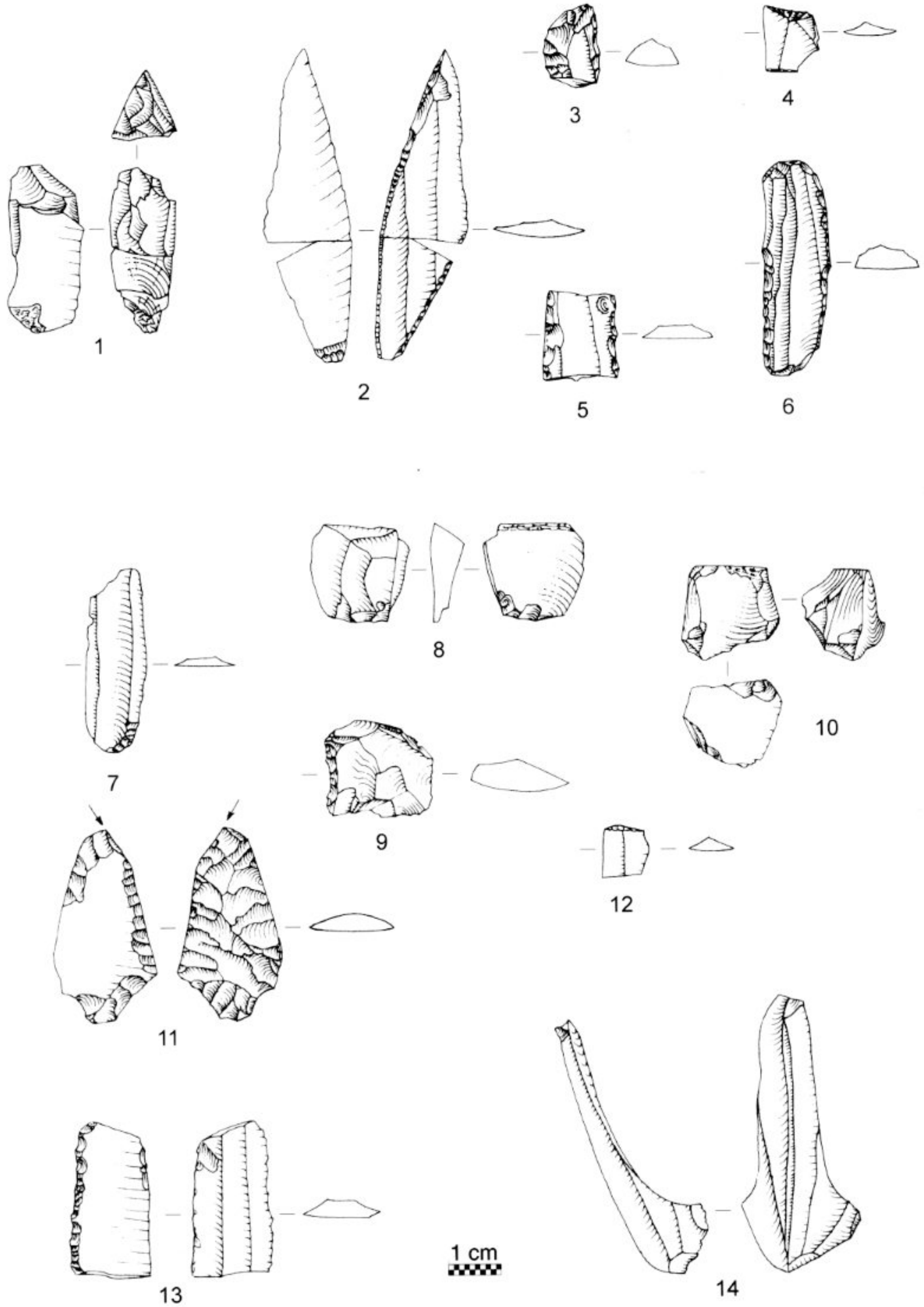

Fig. 8 - Pupićina Cave. A selection of flaked stone artefacts. 1-6: Horizon G; 7-8: Horizon F; 9-10: Horizon A; 11-14: Horizon X.

Artefacts were classified as 'tools' based on simple formal criteria. These are considered to be less ambiguous than functional criteria, since systematic functional studies of artefacts (based on microwear patterns and trace analyses) were not undertaken. An artefact is a formal 'tool' if it exhibits consistent, continuous, or redundant retouch. It is assumed that such retouch was produced either by intentional modification of the blank, or by its continuous, consistent use.

Thirty-six artefacts were classified as tools, which is almost 30% of the total assemblage (table 10). Almost half of them were made on blades or bladelets, while a third were made on flakes. For the rest, blank shape could not be determined.

Scrapers are the most common tool class. They were made with similar frequency on flakes and blades or bladelets. A variety of types are represented, including end scrapers (most numerous), thumbnail scrapers, side scrapers and round scrapers. The next most common class of tools is retouched blades and bladelets. Most of them have normal, semi-abrupt retouch along one or both lateral edges. Other blade-based tools include geometric microliths and a backed bladelet segment. Flake-based tools (aside from scrapers) include retouched flakes, denticulates and scaled pieces. Finally, two carefully shaped arrow points represent the only products of bifacial flaking (fig. 7, n. 10 and 8, n. 11).

ASSEMBLAGE BREAK-DOWN BY OCCUPATION PHASE

Distribution of raw materials and formal types across stratigraphic horizons can be discussed for Neolithic phases of occupation only, since flaked stone artefacts become too scarce in post-Neolithic levels. Even for these levels (stratigraphic horizons I, H and G), flaked stone assemblages are rather small (40, 46 and 15 artefacts, respectively). Nevertheless, a number of revealing temporal trends can be observed in their composition, with regard to preferred raw materials and formal typology of the artefacts.

'Dark cherts' and 'reddish cherts' dominate in the older Middle Neolithic Horizon I, become scarcer in the younger Middle Neolithic Horizon H, and almost disappear by the Late Neolithic Horizon G (table 9; fig. 9). As opposed to that, 'pale cherts' are virtually absent from the earliest Horizon I, appear in quantity in Horizon H, and make up most of the flaked stone artefacts in Horizon G. 'Brown cherts' are present in Horizon I, after which their frequency diminishes. Finally, the only artifact made of obsidian comes from the Late Neolithic Horizon G.

A pattern of increasing presence of non-local raw material during the course of Neolithic thus emerges. Most of the raw material from the older Middle Neolithic sub-phase (Horizon I) is local ('dark cherts' and 'reddish cherts'), while non-local 'pale cherts' are conspicuously absent. The only material from this horizon that may not have been locally procured is 'brown chert' which constitutes about 20% of the assemblage. A few of the local 'dark cherts' may be residual finds from the immediately underlying Mesolithic levels which contained a high number of artefacts made from such cherts, although the break between these levels is very clean.

During the younger sub-phase of Middle Neolithic occupation (Horizon H), the abundance of 'pale cherts' shows that acquisition of non-local raw materials became common.

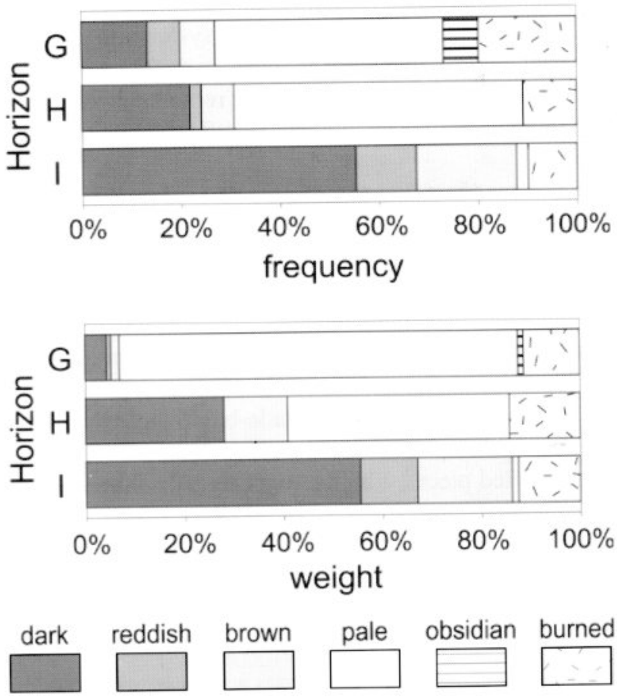

Fig. 9 - Pupićina Cave. Relative frequency (by number and weight) of raw material class by stratigraphic horizon.

	Frequency (N)			Weight (g)		
Raw material	I	H	G	I	H	G
obsidian	0	0	1	0.0	0.0	0.3
dark chert	22	10	2	47.4	32.5	0.4
reddish chert	5	1	1	9.7	0.1	0.2
brown chert	8	3	1	16.5	14.5	0.4
pale chert	1	27	7	1.0	52.1	16.5
indeterminate	4	5	3	10.7	16.4	2.3
Total	40	46	15	85.3	115.6	20.6

Table 9 - Pupićina Cave: raw material classes by stratigraphic horizon.

It became even more common during the Late Neolithic (Horizon G), when an unequivocally exotic material - obsidian - appears for the first time.

Detailed assemblage breakdown by occupation phase is provided in Table 10. Relative quantity of debris, which is greatest in the earliest Horizon I (45%), drops off steadily in later horizons (24% in Horizon H, 13% in Horizon G). As opposed to that, relative number of tools increases from 22.5% in Horizon I to 26% in Horizon H and 53% in Horizon G. *Débitage* is the most common class in Horizon H, but one should add that, in that horizon, blades and bladelets constitute more than half of it (table 6; fig. 10). Therefore, while formal 'waste' clearly dominates the assemblages of both Middle Neolithic sub-phases (Horizons I and H) with relative frequencies that are close to 75%, functional 'waste' in Horizon H is much lower, due to the fact that prismatic blades, clearly made to be used as tools, constitute much of the *débitage*. This shift away from waste is even more obvious during the Late Neolithic phase (Horizon G).

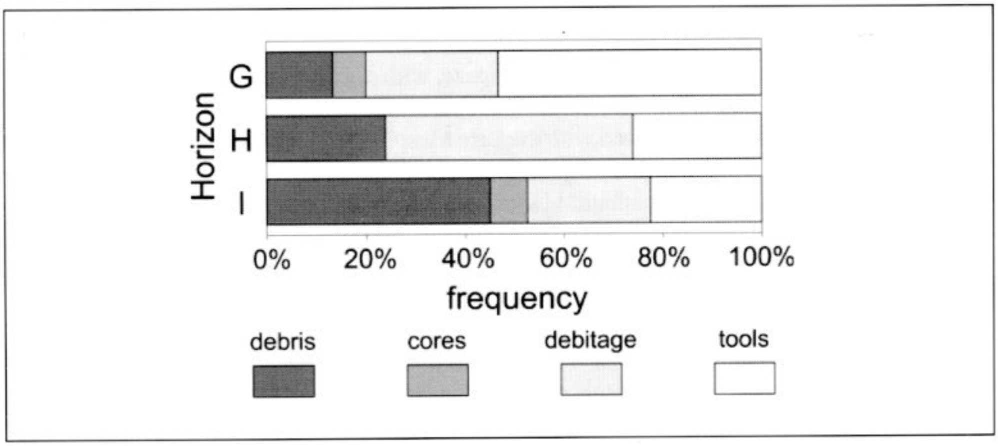

Fig. 10 - Pupićina Cave. Relative frequency of tools, cores, débitage and debris.

This suggests that on-site flintknapping is decreasing in the course of Neolithic, which is in good accord with the already observed increase in non-local raw materials which were brought to Pupićina Cave mostly as prepared cores or finished tools. Some flintknapping was going on at the site during the older Middle Neolithic sub-phase of occupation (Horizon I). This activity was further reduced during the next, younger Middle Neolithic sub-phase (Horizon H), and became almost negligible by the Late Neolithic phase (Horizon G). By then, almost all tools were made of non-local cherts, most of them imported in their final form.

Blade index increases sharply through the Neolithic part of the sequence. Taking into account both *débitage* and tools, the blade/bladelet to flake ratio rises from 0.4:1 in Horizon I to 1.2:1 in Horizon H and 3.5:1 in Horizon G. Bladelets predominate in Horizon I and become outnumbered by blades in later horizons. During the same time period, prismatic blades and bladelets are becoming more common than the irregularly shaped ones. There is also a trend in selection of blank types that were made into tools. While more than half of all tools from the earliest Horizon I were made on flakes, almost all tools from the latest Horizon G were made on blades or bladelets, with the intermediate Horizon H falling between these two extremes.

This strongly suggests that prismatic blade technology became established in Pupiina Cave only during the younger sub-phase of its Middle Neolithic occupation (Horizon H), which is when the non-local 'pale cherts' became widely available, and achieved even greater importance during the Late Neolithic phase (Horizon G).

TOOLS AND CORES BY OCCUPATION PHASE

Horizon I (the older sub-phase of the Middle Neolithic occupation) yielded nine tools. Three of them are scrapers: an end scraper (fig. 7, n. 4), a thumbnail scraper (fig. 7, n. 3), and a very small round scraper with stepped retouch. The rest are a retouched flake (fig. 7, n. 5), a scaled piece (fig. 7, n. 2), a retouched bladelet, a couple of broken retouched fragments, and a geometric microlith (fig. 7, n. 1). All but one was made on flakes. Two of the three small, exhausted core remnants are amorphous, while the third is clearly a product of bipolar reduction (fig. 7, n. 6).

The geometric microlith (fig. 7, n. 1) is a trapeze, with normal retouch along one transversal edge and inverse retouch along the other. This specimen, as well as the other three trapezes from Pupićina, should not be confused with the Late Mesolithic ("Castelnovian") trapezes (e.g. FRELIH, 1986: plate 2; BRODAR, 1992: fig. 5; BIAGI *et al.*, 1993: fig. 7). Those from Pupićina were made on relatively large prismatic blades, apparently without applying the microburin technique. Similar geometric tools appear occasionally in Neolithic levels of the caves of Trieste Karst, such as Grotta degli Zingari (GILLI and MONTAGNARI KOKELJ, 1995: figs. 29, n. 6 and 33, n. 46), or Podmol pri Kastelcu (TURK *et al.*, 1993: fig. 13, n. 8), as well as in the Neolithic open-air sites of northern Italy, such as Valer (FASANI *et al.*, 1993: fig. 4, n. 5).

Horizon H (the younger sub-phase of the Middle Neolithic occupation) yielded 12 tools. Four of them are retouched blades, with normal, semi-abrupt retouch along one or both lateral edges (fig. 7, nn. 13, 15, 18 and 19). Another blade-based tool is a geometric microlith (fig. 7, n. 16). The rest are flake-based tools: a couple of retouched flakes (fig. 7, n. 8), a couple of denticulates (fig. 7, n. 7), an end scraper (fig. 7, n. 9) and a scaled piece. Cores are absent, but a distal fragment of an overshot blade (fig. 7, n. 17) testifies of on-site prismatic core reduction.

One bifacial arrow point was also recovered (fig. 7, n. 10). General analogies for it exist from contexts as diverse as the Middle Neolithic (BENAC, 1958: 38, plate 4; BATOVIĆ, 1963: 98, plate 1; FORENBAHER and VRANJICAN, 1985: 9, plate 1; GILLI and MONTAGNARI KOKELJ, 1993: fig. 30, n. 30; TURK *et al.*, 1993: fig. 13, nn. 5-7) or the Early Bronze Age (PETRIĆ, 1978: 449, fig. 2; BATOVIĆ and KUKOČ, 1987: 63, fig. 2; GILLI and MONTAGNARI KOKELJ, 1995: fig. 35; KAISER and FORENBAHER, 1999: 317-319, fig. 7). A reliable regional typology of bifacial arrow points still needs to be constructed. The main obstacle to that is the fact that most of the arrow points in museum collections are either casual finds, or come from old excavations, lacking reliable contextual information. A few unpublished attempts (DIRJEC, 1975 and OMAN, 1979, as cited and summarized in JOSIPOVIĆ, 1984: 77-79) seem to indicate that many of the formal types cover a very long time span (the entire Middle and Late Neolithic, and possibly even later periods), which means that they can not be used as chronological markers except in the most general sense. A few types would be limited to Late Neolithic and later

Class	Horizon I N	Horizon I %	Horizon H N	Horizon H %	Horizon G N	Horizon G %	later horizons N	later horizons %
Tools	9	*22.5*	12	*26.1*	8	*53.3*	7	*31.8*
arrow points			1		1		1	
bilaterally retouched blades / bladelets			2				1	
laterally retouched blades / bladelets	1		2				1	
backed bladelet					1			
Geometrics	1		1		2			
end scrapers on flake			1		1			
end scrapers on blades / bladelets	1						2	
end scraper on retouched blade					1			
Side scraper							1	
round scraper	1							
thumbnail scrapers	1				1			
retouched flakes	1		2					
Denticulates			2					
broken retouched pieces	2				1			
scaled pieces	1		1				1	
Waste (cores, *débitage*, debris)	31	*77.5*	34	*73.9*	7	*46.7*	15	*68.2*
Cores	3	*7.5*			1	*6.7*	1	*4.5*
Amorphous	2				1			
Microcores	1						1	
Debitage	10	*25.0*	23	*50.0*	4	*26.7*	7	*31.8*
blades and blade segments			9		1		3	
bladelets and bladelet segments	3		4		2		2	
Flakes	7		10		1		2	
Debris	18	*45.0*	11	*23.9*	2	*13.3*	7	*31.8*
Chips	14		10		2		6	
Chunks	4		1				1	
Total	40	*100.0*	46	*100.0*	15	*100.0*	22	*100.0*

Table 10 - Pupićina Cave: assemblage breakdown by phase of occupation.

times. It may serve as a *caveat* that although our specimen comes from a Middle Neolithic context, it is formally closer to one of the later types as proposed by Josipović (1984: fig. 4, nn. 15-17).

Horizon G (the Late Neolithic phase of occupation) yielded eight tools. Among them are geometric microliths, including an elongated piece probably used as arrow point (fig. 8, n. 2), a bilaterally retouched blade segment with 'sickle gloss' along one of its edges (fig. 8, n. 5), an end scraper on a bilaterally retouched blade (fig. 8, n. 6), a small end scraper (fig. 8, n. 4), a thumbnail scraper (fig. 8, n. 3) and a backed bladelet made of obsidian. A single small core fragment shows clear evidence of bipolar reduction (fig. 8, n. 1).

All later horizons combined yielded seven tools, all but one of which come from unknown or insecure contexts, including the disturbed surface Horizon A. Typologically, they compare well with the already discussed tools from Neolithic occupation phases, and include retouched blades and bladelets (fig. 8, n. 13), a couple of miniature end scrapers (fig. 8,

n. 12), a side scraper (fig. 8, n. 9), a scaled piece (fig. 8, n. 8), and a bifacial arrow point (fig. 8, n. 11). Also present is an exhausted amorphous core (fig. 8, n. 10), and another example of an overshot blade which preserves a substantial part of a prismatic core (fig. 8, n. 14).

The arrow point was recovered from the edge of a large recent burrow/pit, and is thus from an uncertain context. It belongs to one of the formal types that, according to Josipović (1984: 79, fig. 4, n. 8), are not chronologically sensitive.

PROCUREMENT, PRODUCTION AND USE

Our analysis suggests that two main classes of raw material were used at Pupićina Cave. The first consists of 'dark' and 'reddish' cherts of inferior quality, which are locally available in small packages. Several primary sources of such cherts have been located within a few hours' walking distance from the site, on the slopes of Učka and Ćićarija mountains. The second class of raw material consists of 'pale' and 'brown' (often, translucent and speckled) cherts of superior quality. Judging by the size and technological characteristics of artefacts, these cherts must have been available in larger packages. While their sources remain unknown, most likely they were not available locally.

If this assumption is correct, a clear shift from local to non-local raw materials is observable during the Neolithic. Majority of flaked stone artefacts from the older sub-phase of the Middle Neolithic occupation were made of locally available chert. In contrast to that, already in the younger sub-phase of the Middle Neolithic, most of the artefacts were made of non-local cherts. In the Late Neolithic phase, dominance of non-local raw materials was augmented by presence of obsidian, a material that is certainly exotic.

Overall high frequency of tools, as well as general scarcity of cores and debris, indicate that flintknapping was not one of the major activities of the post-Mesolithic occupants of the site. Or, to put it more precisely, not much flintknapping was going on at the cave itself. On-site production was somewhat more common during the earliest post-Mesolithic occupation phase (Horizon I). During the later phases (Horizons H and G), on-site flintknapping seems to have been restricted mainly to striking of blades from already prepared prismatic cores.

Prismatic blade technology is the best-documented reduction strategy. Prismatic blades were made primarily from non-local 'pale' and 'brown' cherts. Judging by the scarcity of production waste in general, and flakes and cortical elements in particular, the early stages of blade production (core preparation) were not carried out at the site. A couple of overshot blades that removed large parts of prismatic blade cores indicate that blades were sometimes struck from prepared cores at Pupićina Cave. That does not exclude the possibility that some of the blades were brought to the site in their final form. Our data suggest that this technology may have been introduced to Pupiina already during the older Middle Neolithic sub-phase, but it became well established only during the next, younger Middle Neolithic sub-phase, and even more dominant during the Late Neolithic phase of occupation.

Small flake technology is a less formalized, but equally common reduction strategy. It involved striking of small flakes from amorphous cores and retouching conveniently shaped débitage to make simple tools (such as scrapers, retouched flakes and denticulates), or using the unretouched *débitage*. Judging by the high variability in shape of the *débitage*, as well as such indicators as bulbs of percussion and striking platforms, almost any convenient percussion technique was applied. In this sense, it is an *ad hoc* technology that does not require particular skill or investment. It is possible that the relatively few irregular bladelets are an accidental by-product of the same general reduction strategy. The fact that no bladelet cores were recovered provides some support for this assumption.

By its very nature, such an *ad hoc* technology is not likely to be time-sensitive. At Pupićina Cave, it is best documented during the earliest post-Mesolithic occupation subphase. During the younger sub-phase of the Middle Neolithic it is overtaken by the prismatic blade technology, and by the Late Neolithic it becomes even more marginalized.

Bipolar reduction strategy was used for pieces of raw material, which were too small for other purposes, as indicated, by a number of scaled pieces and bipolar core fragments. This simple technique (CRABTREE, 1972: 10 and 11), while inadequate for producing sophisticated tools, allowed utilization of small pieces of local 'dark cherts' which otherwise could not have been used at all.

Bifacial technology is less well documented, but present nevertheless. It was used exclusively for production of bifacial arrow points. They were made from small conveniently shaped flakes or blade segments by pressure flaking, by removing chip-size bifacial thinning flakes along all edges. As already discussed, the temporal attribution of bifacial artefacts and, with them, of bifacial reduction technology, remains open.

Our data suggest that great care was taken to utilize the available raw material as thoroughly as possible. High level of curation is suggested by the utter exhaustion of cores (all core remnants are tiny), high relative frequency of tools (almost 30% overall), as well as the high frequency of *débitage* with clearly visible edge damage that was probably caused by intensive use. Over 40% of all tools and 27% of *débitage* exhibit edge damage consisting of tiny microflake scars, distributed randomly and discontinuously, usually along either face of thin working edges. Disproportionately high number of blades shows such damage: 63%, as opposed to only 25% of flakes and 7% of bladelets (including those converted to tools). This indicates particularly heavy use of blades, regardless of them being formally retouched or not.

Diversity of discarded tools suggests that a variety of household activities were carried out at the site. Most tools seem to be best suited for cutting and scraping. Almost all are too small to have been used without hafting, and many (such as geometric microliths or blade segments) were probably combined to form composite tools. A single artifact has characteristic luster ('sickle gloss') along one working edge, which possibly was produced by intensive cutting of vegetal material (SEMENOV, 1964: 113-122). Two bifacial arrow points are the only clear examples of weapons, intended either for hunting or for warfare, although a number of other sharply pointed artefacts may have served the same purpose (WENDORF, 1968: 991 and 992). One of these points exhibits an impact fracture at its distal end.

FLAKED STONE ASSEMBLAGE FROM GRAPČEVA CAVE

Grapčeva Cave is another stratified prehistoric site, located some 300 km to the southeast of Pupićina Cave, on the island of Hvar in central Dalmatia. It has been excavated on many occasions over the last 120 years. The most extensive excavations were those carried out by Grga Novak in mid-20th century. Novak published his results in a massive monograph (NOVAK, 1955), launching "Hvar Culture" as one of the most prominent features of the Eastern Adriatic Neolithic. Novak's excavation techniques, however, were rather crude. While he described and illustrated many beautiful potsherds, he provided only cursory information about their contexts, and no accompanying quantitative data.

Novak dealt with other classes of finds, such as lithics, in an even more cursory way. Discussion of flaked stone artefacts takes up only half a page in his monograph (NOVAK, 1955: 265). He reports that only about forty such artefacts were recovered, which makes it clear that his recovery techniques were inadequate. If one presumed that the density of lithics in our 1x2 trench (see below) were representative of the whole site, one would have expected between 1000 and 2000 pieces to have come out of the 100 m^2 area which Novak excavated. In other words, it seems that Novak's excavation missed about 97.5% of all lithics.

NOVAK (1955: plates 239-242) provides photos of 34 flaked stone artefacts "*from various squares, layers and excavation blocks*". Among them are 27 blades (or blade-based tools), six flakes (or flake-based tools), and a single bifacial arrow point. It is evident that these cannot be considered as representative of any particular period, and therefore will not be discussed further.

In May 1996 we carried out a small test excavation[2] with the aim of providing some of the basic information about the site that was missing from Novak's reports, such as a reliable stratigraphic sequence supported by radiocarbon dates. We excavated a 1x2 m test trench through well defined and mostly undisturbed sediments to the bedrock, which we reached at 2.9 m below the modern surface. The chronostratigraphic sequence consists of six stratigraphic phases. The earliest, modest, evidence of human presence, dated roughly to the 6th millennium CAL BC, belongs to the Early and the Middle Neolithic (Phase 0 of Grapčeva Cave, containing a single Impressed Ware sherd and a polychrome painted "figulina" sherd). Particularly well documented is the Late Neolithic occupation (Phases 1 and 2, characterized by Hvar style pottery), which lasted throughout the 5th millennium CAL BC. This is followed by an Early Copper Age occupation (Phase 3, containing Nakovana style sherds and dated to the 4th millennium CAL BC), a Late Copper Age occupation (Phase 4, containing early Cetina style sherds and dated to the 3rd millennium CAL BC), and an Early to Middle Bronze Age occupation (Phase 5, dated to final 3rd and early 2nd millennium CAL BC). More details about site location, morphology, research history, radiocarbon dating, and pottery sequence are available in a preliminary report (FORENBAHER and KAISER, 1999) in Croatian, with an English summary.

Present description and analysis of lithics is limited to the 34 artefacts recovered from our test trench in 1996. After some refitting, this assemblage was further reduced to 29 pieces, weighting in total less than 100 grams. While this is clearly a very small sample to work with, it has the advantage of being accompanied by reliable contextual information.

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[2] This test excavation undertaken as a part of the "Adriatic Islands Project", a joint venture of the University of Birmingham (UK), the Royal Ontario Museum (Toronto, Canada), and the Archaeological Museum in Split (Croatia).

RAW MATERIALS

Analysis of raw material physical characteristics followed the standards and procedures already outlined above. Only 19 pieces were available for that analysis, since the remainder have been burned, and consequently their visual properties (colour and translucency in particular) have been changed. All artefacts were made of relatively light-coloured, fine-grained cherts with regular conchoidal fracture. A variety of colours are represented, including white and off-white (light grey, pale yellow, very pale brown), as well as a variety of yellows, light browns, olives and greys. All are cloudy-translucent and contain light-coloured (white) inclusions in the form of tiny specks, or sometimes larger clouds. They do not fall into any obvious groups.

Size and shape of raw material packages remain unknown, although prismatic blades (one of which is over 9 cm long) could have been produced only from fairly large nodules or blocks. A few pieces with rounded cortical surfaces suggest nodular rather than tabular packages. Sources of these cherts remain unknown. Generally speaking, they belong to the same class of raw material as 'pale' and 'brown' cherts from Pupićina Cave, but this by no means implies that they came from the same sources.

While one might expect at least some low-quality sources of silica rock to exist on the limestone-built island of Hvar, none have been reported so far. Sources of chert are known to exist on the mainland, in the area of Makarska directly across the channel, and those have been sampled (Vujnović, pers. comm. 2004), but sourcing analysis has not been carried out. Technological analysis that follows suggests that the raw material for lithics from Grapčeva Cave was not collected locally.

Heat fracturing and potlids indicate that about a third of all flaked stone artefacts have been thermally altered. Some of the less affected pieces have turned pink or red while retaining their translucency, while those heavily burned are dark (grey or black) and opaque.

Phase	Total (N)	Heated (N)
0	1	0
1	16	2
2	0	0
3	5	3
4	5	4
5	2	1
total	29	10

Table 11 - Grapčeva Cave: thermally altered lithics by phase of occupation.

There is, however, no evidence of intentional heat treatment. To the contrary, judging by several heavily burned tools and blade segments, it seems that these artefacts were accidentally dropped into the fire, or discarded and later heated when fires were built over them. This assumption is further supported by their stratigraphic distribution (table 11): thermally altered pieces are more common in higher levels, which consist to a great part of hearths and other burned features (7 out of 10 pieces from Phases 3 and 4), while such pieces are rare in

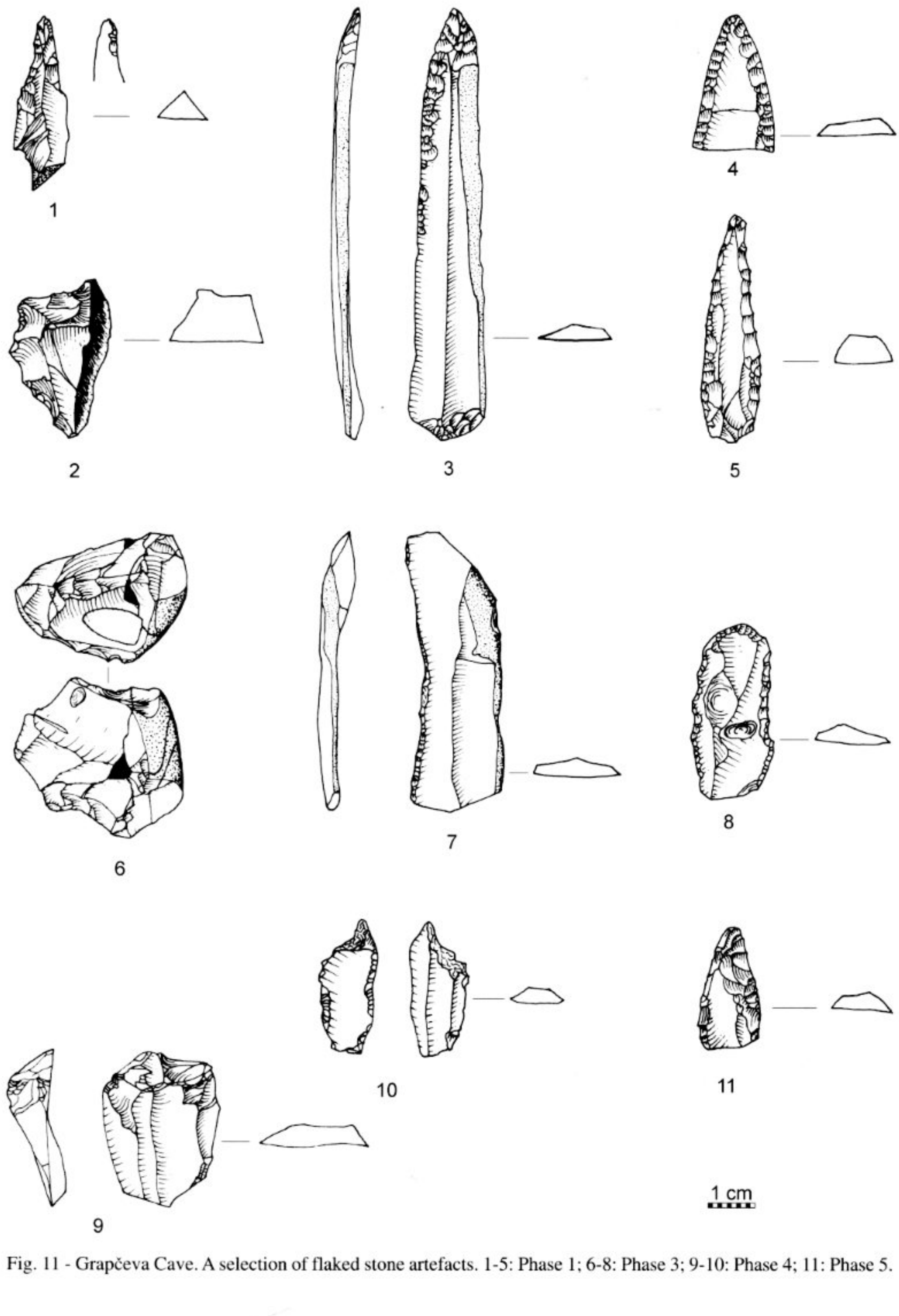

Fig. 11 - Grapčeva Cave. A selection of flaked stone artefacts. 1-5: Phase 1; 6-8: Phase 3; 9-10: Phase 4; 11: Phase 5.

lower levels, which are sedimentologically quite different (2 out of 16 pieces from Phase 1). One may note that the levels corresponding to Phase 1 contain very large amounts of charcoal, but actual burned features are less common when compared to the overlying phases. Explanation of processes responsible for formation of the rather unusual Phase 1 sediments is relegated to a later publication.

ASSEMBLAGE BREAK-DOWN

Tools and *débitage* are equally well represented, each class making up 41% of the total assemblage (table 12). The rest consists of cores and core fragments. Debris (amorphous chunks and flakes smaller than 15 mm) is absent. Such very high incidence of tools, as well as the total absence of debris, which is not a consequence of biased sampling, indicates that very little flintknapping took place at the site. Most of the artefacts must have been imported in their finished or almost finished state.

Blades and bladelets are very common (fig. 11, n. 3 and 7). Together with blade-based tools, they outnumber flakes and flake-based tools at a ratio of 1.18:1. Over two thirds of the blades and blade segments are prismatic, most are trapezoidal in section, and their width ranges from 10 to 20 mm. A few complete examples are relatively short (35-50 mm in length), except for one piece that is over 90 mm long. The rest (3 examples altogether) are small irregular bladelets of triangular section, ranging in width from 6 to 12 mm; the only complete example is 32 mm long.

Four of the five artefacts classified as "cores" are amorphous core fragments. Three of them are splinters produced by bipolar percussion. The fifth is an amorphous flake core, reassembled from five flakes and a core remnant (fig. 11, n. 6).

Formal tools were made on both blades and flakes, but blades were preferentially selected: two thirds of all tools were made on blades. The most common tool is a bilaterally

Class / Phase	0	1	2	3	4	5	Total	
Tools	0	7	0	2	2	1	12	*41%*
"pointed blade"		3				1	4	
retouched blade				2	1		3	
retouched flake		1			1		2	
Drill		1					1	
Denticulate		1					1	
broken retouched piece		1					1	
Cores	0	2	0	3	0	0	5	*17%*
amorphous flake core				1			1	
amorphous core fragment		2		2			4	
Debitage	1	7	0	0	3	1	12	*41%*
flake	1	4			1	1	7	
blade		3			2		5	
Debris	0	0	0	0	0	0	0	*0%*
Total	1	16	0	5	5	2	29	*100%*

Table 12 - Grapčeva Cave: assemblage breakdown by phase of occupation.

Phase	volume (m^3)	weight (g)	density (g/m^3)
0	0,121	0,7	6
1	0,817	33,8	41
2	0,159	0,0	0
3	0,289	44,9	156
4	0,235	11,4	48
5	1,069	2,3	2
Total	2,690	93,1	35

Table 13 - Grapčeva Cave: weight density of flaked stone artefacts by phase.

retouched blade, with normal semiabrupt or abrupt retouch converging to a point at the distal end (fig. 11, nn. 3-5). This tool type is here provisionally called "pointed blade". Four examples were recovered, all made on prismatic blades. Two of these artefacts also have fine, scaly microretouch along sharp edges, which most likely is related to their use. The second most common tool type is retouched blade (fig. 11, nn. 7, 8, 10). There are three of these, each one of them retouched in a quite different manner. While the angle of retouch is always semi-abrupt, it can be normal or inverse, lateral, bilateral or continuous around most of the edges of the artifact. Other tools include a drill made on an irregular bladelet (fig. 11, n. 1), a couple of marginally retouched flakes, a denticulate (fig. 11, n. 2), and a broken retouched piece.

Only a single flake was recovered from Phase 0 (contexts that pre-date the Late Neolithic). More than half of all flaked stone artefacts (16 pieces) came from Phase 1 (Late Neolithic), while Phase 2 (final Late Neolithic) yielded none. Phase 3 (Early Copper Age) and Phase 4 (Late Copper Age) yielded 5 artefacts each. Only a couple of artefacts were recovered from Phase 5 (Bronze Age). Overall weight density of lithics is considerably higher than that in Pupiina Cave (compare tables 7 and 13). The small size of the lithic assemblage is thus primarily a consequence of the small excavated volume.

There are no marked contrasts between the Late Neolithic and the Copper Age assemblages. To the contrary, the two seem to have much in common: similar frequency of formal tools, and a clear preference for prismatic blades. "Pointed blades" seem to characterize the Late Neolithic Phase 1, while retouched blades appear only in Copper Age Phases 3 and 4, but it would be rash to put much of an emphasis on those facts since the respective assemblages are tiny.

Flaked stone artefacts are very scarce in Phase 5 (Bronze Age). In fact, only two artefacts were recovered: a temporally insensitive flake, and a "pointed blade" (fig. 11, n. 11), both from the Middle Bronze Age Subphase 5.2. These may be interpreted as residual finds from Neolithic or Copper Age levels.

PROCUREMENT, PRODUCTION AND USE

Breakdown of the lithic assemblage by technological class suggests that flintknapping was not at all a common activity at the site. To the contrary, most of the chert seems to has been brought in as finished tools. Virtually all blades and two thirds of all flakes were either retouched or used in unretouched form (see below). Cores are utterly exhausted: the only amorphous flake core that was recovered has been refitted from five small flakes and a tiny core remnant, and most of the other core fragments are nothing more but splinters produced by bipolar reduction of otherwise useless pieces of chert.

All this suggests that chert was used economically and considered a scarce commodity. Apparently, raw material was not readily available, but was acquired only with considerable effort. The closest known sources of chert are located on the mainland, some 30 km away across the channel. If chert had to be acquired from these (or other, presently unknown) sources on the mainland, its procurement would have involved either relatively long and potentially dangerous trips, or long-distance exchange.

The refitted flake core (fig. 11, n. 6) provides evidence of occasional flintknapping at the site. In this case, a small remnant of a chert nodule was reduced by direct hard hammer percussion (judging by prominent bulbs and crushed platforms). A series of irregular small flakes were produced and, apparently, discarded without being used. The impression is that someone was trying to produce a few expedient tools from a core that was virtually exhausted, but was dissatisfied with the result, and abandoned them together with the remaining part of the core.

Bipolar percussion technique, which was employed to reduce small and otherwise useless core remnants, is attested by three core fragments and an irregular elongated piece of *débitage*. There is scarcely any other evidence of on-site production. Debris is totally absent. *Débitage* is dominated by blades, which, even if not formally retouched, cannot be regarded as production waste. Six artefacts (about a fifth of the total assemblage) are cortical, but most of them have only vestiges of cortex. Only a single decortication flake can be considered "primary *débitage*". The fact that formal tools make up over 40% of the total assemblage clearly testifies that a large number of tools must have been brought to the site in their final form.

Prismatic blade technology was clearly the dominant reduction strategy, but there is no evidence that any phase of blade production was carried out at the site. A possible exception is an overshot flake which was struck from a core that apparently was set up to produce short prismatic blades (fig. 11, n. 4), but even this piece may have been brought to the site to be used as a tool, rather than struck there.

While evidence of on-site production is scarce, the cave may be considered as the place where finished tools were brought to be used and eventually discarded. Over a third of all flakes and over two thirds of all blades were retouched , that is, made into formal tools. Many of the unretouched pieces of *débitage* have use-related microretouch along parts of their edges. When these are added to the formal tools, it comes out that about two thirds of all flakes, as well as virtually all blades (including all prismatic blades) were utilized in some way. Judging by their size, most of these artefacts must have been hafted, and many may have been used as elements of composite tools.

To the extent that function can be deduced from form, it seems that many of the artefacts were used for cutting, while very few, if any, were used for scraping (most of the working edges are too thin to be effectively used for scraping, and the assemblage does not contain a single formal scraper). Function of "pointed blades" (fig. 11, nn. 3-5) remains unknown.

Judging by the fact that, in addition to their point, they also have sharp lateral edges (which sometimes exhibit use-related microretouch), these may have been multiple-purpose cutting and piercing tools. A relatively thick example (fig. 11, n. 5) resembles Early Neolithic "shell-openers" from Sušac and Coppa Nevigata (BASS, 1998: 169, fig. 4), but close analogies can also be found at Middle Neolithic settlements such as Danilo (KOROŠEC, 1958: plates 53 and 54), or Late Neolithic settlements such as Lisičići (BENAC, 1958: plate 3: 13-15). The tool classified as a "drill" (fig. 11, n. 1) is also close to this formal group of artefacts.

DISCUSSION

The reader should beware that much of what follows is based on two small lithic assemblages, both of them from caves. The reason for that is simple. Aside from Pupićina and Grapčeva collections, there are no other lithic assemblages available along the entire length of the eastern Adriatic that have been both systematically recovered and comprehensively published. The only site that comes close to meeting those requirements is Grotta degli Zingari (GILLI and MONTAGNARI KOKELJ, 1995: 88-96 and 99-100), at the northeastern end of the Adriatic. Assemblages from the relatively recent and methodologically sound excavations, such as those at Tinj (MARTINELLI, 1990: 131-133; CHAPMAN *et al.*, 1996: 192 and 193) and Sušac (BASS, 1998: 169-171), have not been published yet in any detail.

Information about lithics from a number of important sites that were excavated half a century ago, such as Smilčić (BATOVIĆ, 1961: 35-45; 1963: 97 and 98), Danilo (KOROŠEC, 1958: 27-33), Lisičići (BENAC, 1958: 37-38), or Markova Cave (ČEČUK, 1968; 1974; 1976; 1982), is generally very sparse and unreliable due to low excavation standards and summary reporting. While re-examination of those collections may produce valuable new information (e.g. MARTINELLI, 1990), the author of this paper doubts that it will ever provide a sound base for quantitative synchronic and diachronic analyses. A detailed analysis of such an assemblage - the one from Vižula - has been published recently (CODACCI, 2002), but its scope is severely limited by inadequate recovery practices of the times and unreliable information about contexts. It is, therefore, not surprising that general statements about flaked stone industries of the eastern Adriatic are few (e.g, MARTINELLI, 1990; MÜLLER, 1994: 163-170) and often compromised by the unsatisfactory character of the data on which they are based.

The small assemblages from Pupićina and Grapčeva caves posses the virtues of being recovered according to contemporary standard practices, and are accompanied by sound contextual information, allowing meaningful quantitative analysis and identification of temporal trends. The assemblage from Pupićina Cave is the bigger of the two, and it covers earlier periods, beginning with the Middle Neolithic (Danilo-Vlaška phase).

TEMPORAL TRENDS

One of the temporal trends observed at Pupićina is an increasing use of non-local sources of lithic raw material. This is paralleled by a shift from mostly flake-based industry to an industry dominated by prismatic blade technology, and a decrease in on-site flinknapping.

During the earlier part of the Middle Neolithic, the occupants of Pupićina Cave acquired most of the raw materials for their flaked stone tools locally. Most of those tools, such as scrapers, retouched flakes, or scaled pieces, were made by employing simple *ad hoc* flaking strategies. While primary reduction of raw material was carried out away from the site (most likely, at the source), later stages of reduction were sometimes, if not too often, completed at the site itself. Prismatic blade technology, if practiced at all, certainly was not common.

During the later part of the Middle Neolithic, use of non-local raw material increased dramatically at Pupićina. Most of it was brought to the site either in the shape of prismatic blade cores, or as already finished blades. Blade technology became well established and replaced *ad hoc* flaking technologies as the dominant strategy for making flaked stone tools such as retouched blades, geometric microliths, or end scrapers on blades. Aside from occasional striking of blades from already prepared cores, however, most of the reduction was carried out away from the site, presumably at or near the source. It should be added that *ad hoc* flaking technologies were not abandoned, but continued to contribute considerably to the production of tools such as scrapers, denticulates, retouched flakes or scaled pieces.

The same trends became even more pronounced at Pupićina during the Late Neolithic, the period characterized by Hvar style pottery. Absolute dominance of non-local raw materials is augmented by the first and only appearance of an unquestionable exotic, obsidian imported from Lipari Islands in the southern Tyrrhenian basin. This is accompanied by an even more evident dominance of blade technology over all other production strategies. Judging by the high frequency of formal tools (53%) and a low frequency of debris (13%), there was very little on-site flintknapping.

In general terms, lithics from the Late Neolithic (Hvar) contexts of Grapčeva Cave compare well with the contemporary lithics from Pupićina. While we know very little about provenience of raw materials, there are indications that they were not locally obtained. Very little flintknapping was carried out at the site, as shown by high frequency of formal tools (44% in Grapčeva Phase 1) and a total absence of debris. A couple of amorphous core fragments testify of occasional *ad hoc* on-site production. Prismatic blade industry dominates: with tools included, blades/bladelets outnumber flakes, prismatic blades outnumber irregular bladelets, and tools are preferentially made on blades.

Similar temporal trends have been reported from Grotta degli Zingari in Trieste Karst (GILLI and MONTAGNARI KOKELJ, 1995: 88-96 and 99-100). A large lithic assemblage from an earlier Neolithic phase of that site contains some imported raw materials and a few prismatic blades. It is followed by a smaller assemblage attributed to a later Neolithic phase, which contains more imported raw materials and many prismatic blades.

The shift from flakes to blades is also noted by MARTINELLI (1990) who analyzed and compared the available Early Neolithic and Middle to Late Neolithic collections from Dalmatian sites of Smilčić, Danilo, Tinj and Škarin Samograd. Her conclusion is that the Early Neolithic (Impressed Ware phase) industries at those sites are based on small flakes and blade-like flakes, while Middle to Late Neolithic industries (associated with Danilo and Hvar wares) are based on blades (MARTINELLI, 1990: 146 and 147, table 3). She also notes that obsidian - an unquestionably exotic raw material - is absent from the Early Neolithic (Impressed Ware) contexts (MARTINELLI, 1990: table 1).

INTRODUCTION OF THE PRISMATIC BLADE TECHNOLOGY

The picture outlined above is partially at odds with the accepted wisdom by which all Neolithic lithic industries, from the early Impressed Ware onwards, are based on blade technology (BATOVIĆ, 1979: 502; MÜLLER, 1994: 164 and 165). Blades have been recovered from various contexts that cover most of the Neolithic, Copper Age, as well as the earliest Bronze Age (e.g. BENAC, 1958: 37, plate 3; KOROŠEC, 1958: 30 and 31, plates 60-66; ČEČUK, 1974: 223-228, plates 1-7; FORENBAHER and VRANJICAN, 1985: 9, plate 1; MÜLLER, 1988: 114, fig. 10; TURK *et al.*, 1992: fig. 7; 1993: fig. 13, nn. 1-3; FASANI *et al.*, 1993: figs. 4 and 5; GILLI and MONTAGNARI KOKELJ, 1993: fig. 30: 24-29; 1996: fig. 29 and 33; KAISER and FORENBAHER, 1999: 317, fig. 6). A careful survey of the few existing lithics reports will show, however, that the hypothesis of blade technology dominance from the beginning of Neolithic stands on shaky legs.

First of all, traditional excavation methods have created a major sampling problem. Aside from Pupićina and Grapčeva, sieving has been systematically employed at only a couple of recently excavated sites (Tinj, Sušac), but lithic collections from those excavations have not been published yet. Consequently, arguments were based on finds from surveys or excavations in which haphazard recovery of lithics was the rule. Judicious collection of flaked stone artefacts invariably leads to overrepresentation of large and 'nice' pieces, such as blades, while smaller and less attractive flakes and debris get underrepresented.

Secondly, while reports normally include long discussions of formal characteristics of pottery (with the aim of constructing typo-chronological sequences), the accompanying lithics usually get only casual treatment (e.g. KOROŠEC and KOROŠEC, 1974: 11; BRUSIĆ, 1995: 8). Efforts are made exceptionally to treat lithics more extensively (see BATOVIĆ, 1961: 35-45; 1963: 97 and 98 for lithics from Smilčič, and ČEČUK, 1968; 1974; 1976 and 1982 for those from Markova Cave), but even in those examples, all finds tend to be treated in bulk, with little regard to their provenience from Early, Middle of Late Neolithic contexts. These two factors in conjunction contribute to an impression that Neolithic lithic industries were blade-based from the very beginning.

Nevertheless, lithic reports by Batović and Čečuk contain information that makes it clear that there are differences between lithic assemblages from Early Neolithic (Impressed Ware) and Middle Neolithic (Danilo) contexts. Both authors note that flaked stone artefacts are rare in Early Neolithic, but numerous in Middle Neolithic contexts. One is tempted to suspect that many of the Early Neolithic lithics were small and nondescript, and therefore not recovered. Out of over a thousand lithic artefacts from Smilčić, Batović attributes only 25 to the Impressed Ware phase of that site (BATOVIĆ, 1963: 97; 1979: 502), including "*knives, scrapers,* débitage, *as well as few grinding stones and whetstones*". Clearly, there could not have been too many blades among these. Similarly, out of hundreds of artefacts from Neolithic levels of Markova Cave, only 17 came from Impressed Ware contexts (ČEČUK, 1974: 234, plate 9: 2 and 3 and plate 13). Less then half of them are blades or blade-based tools. With some significance, Čečuk reports that Impressed Ware levels contained "*microlithic flint artefacts, as well as artefacts whose origin can and should be sought in Paleolithic cultures*" (ČEČUK, 1976: 50), and that "*knives... appear in all levels... while archaic types of scrapers are to be found only in the deepest levels*" (ČEČUK, 1982: 59). Furthermore, flakes (or *débitage*?) appear to be more common than "knives" among the 36 flaked stone artefacts from Early Neolithic contexts in Nin (BATOVIĆ, 1979: 502). Taken at face value, this scarce information does not support the claim that the Early Neolithic (Impressed Ware phase) lithic industries at these three sites were blade-based.

One may add to this observations by BENAC (1975: 128, 140, plates 4 and 7), who notes "*small artefacts of Mesolithic tradition*" in Level III (Impressed Ware) of Crvena Stijena. While large prismatic blades, some of them "*already shaped as true Neolithic tools*", also appear in that level, they are more common in the following Level II (Middle Neolithic), where lithics are also generally larger. Similarly, Level IIb (Impressed Ware) of Odmut contained some prismatic blades, but only the assemblage from the following Level III (loosely attributed to Late Neolithic) is dominated by prismatic blades (MARKOVIĆ, 1985: 39, 40, plate 23).

In a more recent contribution, Müller produced a general statement on Early Neolithic flaked stone artefacts in the Eastern Adriatic (MÜLLER, 1994: 163-170). Unfortunately, he was able to analyze only 74 artefacts, collected in a haphazard way from seven different sites. This can hardly be called a representative sample, and Müller commendably admits its inadequacy (MÜLLER, 1994: 168). Nevertheless, he draws some far-reaching conclusions about the blade-based character of the Early Neolithic lithic industries and their relationship (or the lack of it) to their Mesolithic predecessors (MÜLLER, 1994: 164-165 and 202-203).

The small, remote island of Sušac yielded one of the rare systematically recovered Early Neolithic lithic assemblages. Preliminary impression of the excavator is a "*strong tendency towards blades*" (BASS, 1998: 169). Definite judgment must be withheld, however, until basic statistics become available. Another systematically recovered Early Neolithic assemblage comes from Tinj and consists of 225 flaked stone artefacts. The excavators offer only a briefest general description of its contents and characterize it as a "non-geometric, blade-based assemblage[3] with a marked preference for truncations" (CHAPMAN *et al.*, 1996: 193). It is noteworthy, however, that Martinelli in her analysis of the same assemblage[3] came to a different conclusion. In her opinion, the lithic industry at Tinj is based on small flakes and blade-like flakes (MARTINELLI, 1990: 131). According to the quantitative data that she provides, blades make up only 18% of the *débitage* (MARTINELLI, 1990: 133, table 3).

In conclusion, the generally accepted notion that the Eastern Adriatic Neolithic flaked stone industries fully rely on blade technology from the very beginning needs to be reconsidered. At least at one site, Pupićina Cave, that is clearly not the case. Careful reading of reports from several other sites suggests that this situation is not site- or region-specific. Rather than that, it may in fact characterize the entire region. If that eventually turns out to be true, the "early dominance of blade technology" hypothesis will have to be discarded as an erroneous impression that is to be blamed on inadequate recovery techniques and incomplete publication.

[3] There is a slight discrepancy regarding the size of the assemblage from Tinj: MARTINELLI (1990: 133) works with 204 flaked stone artefacts, while CHAPMAN *et al.* (1996) report 225.

COPPER AGE AND BRONZE AGE

The eastern Adriatic Copper Age is still poorly known (PETRIĆ, 1976; DIMITRIJEVIĆ, 1979; MARIJANOVIĆ, 1992; FORENBAHER, 2000). There is even less information about flaked stone industries of the period. Excavations at Pupićina and Grapčeva yielded very little material that could fill this lacuna. Pupićina was only rarely visited during the Copper Age (FORENBAHER *et al.*, 2004: 78) and none of its lithics can be safely attributed to that period. Copper Age levels of Grapčeva (Phases 3 and 4, corresponding, respectively, to Nakovana and early Cetina pottery styles) yielded only ten flaked stone artefacts (table 12). Technological and typological composition of this tiny assemblage does not seem to differ significantly from the same site's Late Neolithic assemblage. Tools are frequent (four out of ten pieces, three of which are retouched blades), blades and blade-based tools clearly outnumber flakes and flake-based tools, and a single refitted flake core (possibly, of local chert) testifies of occasional on-site production of *ad hoc* tools. It would be unwise, however, to draw hasty conclusions from such a small sample that comes from levels that cover both the Early and the Late Copper Age.

A late Copper Age site on the remote island of Palagruža yielded a large lithic assemblage dominated by prismatic blades and characterized by a large number of bifacial arrow points (KAISER and FORENBAHER, 1999). A production site linked to a local chert source, Palagruža shows that production of flaked stone tools was alive and well at least until the end of the Copper Age.

There is some evidence that flaked stone tools went out of use soon after the onset of the Bronze Age. Lithics are almost never reported from Bronze Age sites, although, to some extent, this again may be a consequence of selective reporting. On the other hand, Pupićina and Grapčeva provide data in support of the aforementioned interpretation. Middle Bronze Age occupation at Pupićina Cave is well documented, but it seems that flaked stone tools were no longer used in any significant number. Similarly, Bronze Age occupation levels of Grapčeva Cave yielded only two flaked stone artefacts, which are regarded residual finds from Neolithic or Copper Age levels.

IN PLACE OF CONCLUSION

Meaningful discussion of the eastern Adriatic flaked stone industries, and the dynamics of their change during Neolithic and Copper Age, continues to be hampered by an acute deficit of systematically collected assemblages and detailed reports of their contents. The assemblages from Pupićina and Grapčeva caves can serve as an illustration of what may be learned from analyses of systematically recovered samples accompanied by detailed and reliable contextual information. They are, however, too few and too small to provide any definite answers. Rather than that, they focus our attention to several important and as yet unresolved questions.

The first of these question relates to timing and dynamics of the introduction of prismatic blade technology. Our data, in conjunction with information carefully gleaned from published reports, suggest a gradually increasing reliance on this technology, which became firmly established only during the Middle Neolithic (Danilo phase). This issue is of a major consequence for understanding the relationship between the Late Mesolithic and the Early Neolithic (Impressed Ware phase) flaked stone industries.

Currently, there is no evidence that bifacial pressure flaking, responsible for production of arrow points, was introduced before the Middle Neolithic (Danilo phase). Once these two technologies were in place, apparently there was no dramatic qualitative change until the end of the Copper Age. Assemblages from Pupićina and Grapčeva suggest that change may have been primarily quantitative: *ad hoc* flaking, prismatic blade production and bifacial pressure flaking probably continued during those periods, but their relative contribution seems to have varied through time. Quantitative data, unrecoverable for assemblages from old excavations, are a crucial prerequisite for investigating this issue further. Persistence of an expedient (*"ad hoc"*) flake technology with little formalization, and an essentially unchanging prismatic blade technology, would mean that most of the artefacts would be temporally insensitive, and therefore of little use for traditional "dating" purposes. Bifacial arrow points may be an exception, but their stylistic variability and possible temporal change still need to be documented convincingly.

How should we interpret the trends, discernable primarily at Pupićina and Grapčeva, of decreasing on-site production and increasing dependence on imported raw materials, paralleled by growing reliance on prismatic blades? These trends may reflect changes in organization of production. Prismatic blade technology requires a rather sophisticated set of tools and accessories, as well as a high level of skill (Crabtree, 1968; Clark, 1987: 267–268). It requires fairly substantial investment, which makes economic sense only if the output is high, that is, if the products are made with the intention to be exchanged (Clark, 1987: 270 and 271). The combined evidence thus hints at the possibility that craft specialists may have carried out specific segments of lithic production, and that specialized production increased towards the end of the Neolithic and later.

When does flaked stone technology finally become obsolete? It seems that, by the Middle Bronze Age, lithics are seldom used. A more decisive answer to this question, and to all other questions discussed above, will entirely depend on future fieldwork that should provide information that meets current professional standards.

REFERENCES

ANDREFSKY, W. 1998 - *Lithics: Macroscopic Approaches to Analysis*. Cambridge University Press, Cambridge.

BASS, B. 1998 - Early Neolithic Offshore Accounts: Remote Islands, Maritime Exploitations, and the Trans-Adriatic Cultural Network. *Journal of Mediterranean Archaeology*, 11 (2): 165-190.

BATOVIĆ, Š. 1961 - Neolitsko nalazište u Smilčiću. *Diadora*, 2: 31-116. Zadar.

BATOVIĆ, Š. 1963 - Neolitsko naselje Smilčić. *Radovi Instituta JAZU u Zadru*, 10(2): 89-138. Zadar.

BATOVIĆ, Š. 1979 - Jadranska zona. In BENAC, A. (ed.) *Praistorija jugoslavenskih zemalja*, vol. 2: 473-635. ANUBiH, Sarajevo.

BATOVIĆ, Š. and KUKOČ, S. 1987 - Podvršje - Matkov Brig: grobni humak iz ranog brončanog doba. *Arheološki pregled*, 27: 61-63. Ljubljana.

BENAC, A. 1958 - *Neolitsko naselje u Lisičićima kod Konjica*. Naučno društvo Bosne i Hercegovine, Sarajevo.

BENAC, A. 1975 - Mlađi praistorijski periodi u Crvenoj stijeni. In *Crvena stijena, zbormik radova*. In BASLER, (ed.) *Nikšić: Zajednica kulturnih ustanova*: 121-169.

BIAGI, P., STARNINI, E. and VOYTEK, B. 1993 - The Late Mesolithic and Early Neolithic Settlement of Northern Italy: Recent Considerations. *Poročilo o raziskovanju paleolitika, neolitika in eneolitika v Sloveniji*, 21: 45-67. Ljubljana.

BRODAR, M. 1992 - Mezolitsko najdišče Pod Črmukljo pri Šembijah. *Arheološki vestnik*, 43: 23-36. Ljubljana.

BRUSIĆ, Z. 1995 - Naselje iz starijeg neolitika na Vrbici kod Bribira. *Diadora*, 16-17: 1-49. Zadar.

BUCCICH, G. 1885 - Ricerche preistoriche sull' isola di Lesina. *Bolletino di archeologia e storia dalmata*, supplemento, 8: 1-11.

CHAPMAN, J.C., SHIEL, R.S. and BATOVIĆ, Š. 1996 - *The Changing Face of Dalmatia*. Leicester University Press, London.

CLARK, J.E. 1987 - Politics, Prismatic blades, and Mesoamerican Civilization. In JOHNSON, J.K. and MORROW, C.A. (eds.) *The Organization of Core Technology*: 259-284. Westview Press, Boulder.

CODACCI, G. 2002 - Il sito neolitico di Vižula: analisi tipologica dell'industria litica. *Histria Archaeologica*, 33: 143-193. Pula.

COLLINS, M.B. and FENWICK, J.M. 1974 - Heat Treating of Chert: Methods of Interpretation and their Application. *Plains Anthropologist*, 19: 134-145.

CRABTREE, D.E. 1968 - Mesoamerican Polyhedral Cores and Prismatic Blades. *American Antiquity*, 33: 446-477.

CRABTREE, D.E. 1972 - An Introduction to Flintworking. *Occasional Papers of the Idaho State University Museum*, 28: 1-98.

ČEČUK, B. 1968 - Kamene i koštane rukotvorine Markove spilje (Iskapanje 1962. godine). *Arheološki radovi i rasprave*, 6: 181-212. Zagreb.

ČEČUK, B. 1974 - Kamene i koštane rukotvorine Markove spilje II. *Arheološki radovi i rasprave*, 7: 221-258. Zagreb.

ČEČUK, B. 1976 - Kamena i koštana industrija Markove spilje. *Materijali Saveza arheoloških društava Jugoslavije*, 12: 47-54.

Čečuk, B. 1982 - Kamene i koštane rukotvorine Markove spilje. *Arheološki radovi i rasprave*, 8-9: 35-62. Zagreb.

Dimitrijević, S. 1979 - Problem eneolita na istočnoj jadranskoj obali. In Tasić, N. (ed.) *Praistorija jugoslavenskih zemalja*, vol. 3: 367-379. ANUBiH, Sarajevo.

Fasani, L., Biagi, P., D'Amico, C., Starnini, E. and Voytek, B. 1993 - Stazione neolitica a Valer (Azzano Decimo - Pordenone): rapporto preliminare degli scavi 1990-1991. *Atti della Società per la Preistoria e Protostoria della Regione Friuli-Venezia Giulia*, VIII: 97-113. Trieste.

Forenbaher, S. 2000 - "Nakovana Culture": State of Research. *Opuscula archeologica*, 23-24: 373-385. Zagreb.

Forenbaher, S. and Kaiser, T. 1999 - Grapčeva spilja i apsolutno datiranje istočnojadranskog neolitika. *Vjesnik za arheologiju i historiju dalmatinsku*, 92: 9-34. Zagreb.

Forenbaher, S. and Vranjican, P. 1985 - Vaganačka pećina. *Opuscula archeologica*, 10: 1-21. Zagreb.

Forenbaher, S., Kaiser, T. and Miracle, P.T. 2004 - Pupićina Cave Pottery and the Neolithic Sequence in Northeastern Adriatic. *Atti della Società per la Preistoria e Protostoria della regione Friuli-Venezia Giulia*, XIV: 61-102. Trieste.

Gilli, E. and Montagnari Kokelj, E. 1993 - La Grotta delle Gallerie nel Carso Triestino. *Atti della Società per la Preistoria e Protostoria della Regione Friuli-Venezia Giulia*, VIII: 121-194. Trieste.

Gilli, E. and Montagnari Kokelj, E. 1995 - La Grotta degli Zingari nel Carso Triestino (materiali degli scavi 1961-1965). *Atti della Società per la Preistoria e Protostoria della Regione Friuli-Venezia Giulia*, IX: 63-126. Trieste.

Josipovič, D. 1984 - Kamena industrija z Luž pri Šenčurju in neo-eneolitska naselbina na Štefanji gori. *Poročilo o raziskovanju paleolitika, neolitika in eneolitika v Sloveniji*, 12: 73-89. Ljubljana.

Kaiser, T. and Forenbaher, S. 1999 - Adriatic Sailors and Stone Knappers: Palagruža in the 3rd Millennium B.C. *Antiquity*, 73: 313-324.

Korošec, J. 1958 - *Neolitska naseobina u Danilu Bitinju*. JAZU, Zagreb.

Korošec, J. and Korošec, P. 1974 - Bribir i njegova okolica u prapovijesno doba. *Diadora*, 7: 5-33. Zadar.

Luedtke, B.E. 1992 - *An Archaeologist's Guide to Chert and Flint*. Institute of Archaeology, UCLA, Los Angeles.

Marijanović, B. 1992 - Neka pitanja eneolitika istočnog jadrana. *Diadora*, 14: 5-21. Zadar.

Marković, Č. 1985 - *Neolit Crne Gore*. Filozofski fakultet, Beograd.

Marović, I. and Čović, B. 1983 - Cetinska kultura. In Čović, B. (ed.) *Praistorija jugoslavenskih zemalja*, vol. 4: 191-231. ANUBiH, Sarajevo.

Martinelli, M.C. 1990 - Industrie litiche di alcuni siti neolitici della Dalmazia e loro raffronti con contemporanee industrie dell'Italia sud-adriatica e delle Isole Eolie. *Rassegna di Archeologia*, 9: 125-151. Firenze.

Miracle, P.T. and Forenbaher, S. in press - Excavations at Pupićina Cave. In Miracle, P.T. and Forenbaher, S. (eds.) *Archaeology of Pupićina Cave: Prehistoric Herders of Northeastern Istria*. Arheološki muzej Istre, Pula.

Müller, J. 1988 - Cultural definition and interaction of the eastern Adriatic Early Neolithic. *Berytus*, 36: 101-125.

Müller, J. 1994 - *Das Ostadriatische Frühneolithikum: Die Impresso-Kultur und die Neolithisierung des Adriaraumes*. Volker Spiess, Berlin.

Novak, G. 1955 - *Prethistorijski Hvar, Grapčeva spilja*. JAZU, Zagreb.

Petrić, N. 1976 - Prethistorijske kulture Pelješca. *Pelješki zbornik*, 1: 295-313.

Petrić, N. 1978 - Prilozi pretpovijesti Istre. *Jadranski zbornik*, 10: 441-464.

Semenov, S. A. 1964 - *Prehistoric Technology, an Experimental Study of the Oldest Tools and Artefacts from Traces of Manufacture and Wear*. Barns and Noble, New York.

Tixier, J. 1963 - *Typologie de l'épipaleolithique du Maghreb*. Centre de recherches antropologiques, préhistoriques et éthnologiques. Alger, Paris.

Turk, I., Bavdek, A., Perko, V., Culiberg, M., Šercelj, A., Dirjec, J. and Pavlin, P. 1992 - Acijev spodmol pri Petrinjah, Slovenija. *Poročilo o raziskovanju paleolita, neolita in eneolita v Sloveniji*, 20: 27-48. Ljubljana.

Turk, I., Modrijan, Z., Prus, T., Cuiberg, M., Šercelj, A., Perko, V., Dirjec, J. and Pavlin, P. 1993 - Podmol pri Kastelcu, novo večplastno arheološko najdišče na Krasu, Slovenija. *Arheološki vestnik*, 44: 45-96. Ljubljana.

Tykot, R.H. 1996 - Obsidian Procurement and Distribution in Central and Western Mediterranean. *Journal of Mediterranean Archaeology*, 9 (1): 39-82.

Wendorf, F. 1968 - Site 117: A Nubian Final Paleolithic Graveyard Near Jebel Sahaba, Sudan. In Wendorf, F. (ed.) *The Prehistory of Nubia*, vol. 2: 954-995. SMU Press, Dallas.

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