

# Impressed Ware blade production of Northern Dalmatia (Eastern Adriatic, Croatia) in the context of Neolithisation

Sonja Kačar

Laboratoire TRACES UMR 5608, Université de Toulouse 2 – Jean Jaurès, Toulouse, FR  
sonja.kacar@gmail.com

**ABSTRACT** – *The lithic assemblages from the principal early Neolithic sites in Northern Dalmatia have been analysed with respect to the technological aspects and principles of schéma and chaîne opératoire, débitage economy and raw material economy. Northern Dalmatia, the most fertile region of the Eastern Adriatic, hosts the most important Neolithic open-air sites. Early Neolithic is associated with the Impressed Ware culture and dates back to c. 6000–5400 cal BC. The Early Neolithic lithic assemblages are characterized by the pressure blade production techniques on high-quality Gargano cherts reflecting important socio-economic and technical mutations that are specific to the Neolithic. Moreover, the almost exclusive reliance on these exogenous cherts emphasizes the social aspects of such networks and reinforces the idea of cultural uniformity of Dalmatian and Apulian Impressed Ware.*

**KEY WORDS** – *lithic technology; Neolithisation; Dalmatia; Adriatic; Impressed ware; pressure flaking; Castelnovian*

## **Izdelava klin tipa Impresso v severni Dalmaciji (Vzhodni Jadran, Hrvaška) v kontekstu neolitizacije**

**IZVLEČEK** – *Analizirali smo zbirke kamnitih orodij iz najpomembnejših zgodnje neolitskih najdišč v severni Dalmaciji, pri čemer smo upoštevali predvsem tehnološke aspekte in principa schéma in chaîne opératoire, ekonomijo kamnitega odpada in ekonomijo surovin. Najpomembnejša neolitska najdišča na prostem so locirana v Severni Dalmaciji, ki je najbolj rodovitna regija na Vzhodnem Jadranu. Zgodnji neolitik tukaj povezujemo s kulturo Impresso, ki datira v čas ok. 6000 do 5400 pr. n. št. Zgodnje neolitski zbirki kamnitih orodij so vezani na tehnologijo izdelave klin izdelanih iz visoko kakovostnih rožencev, ki prihajajo iz polotoka Gargano v Italiji, kar odseva pomembne družbeno-ekonomske in tehnične spremembe, ki so specifične za obdobje neolitika. Poleg tega uporaba rožencev, ki prihaja skoraj izključno iz drugih pokrajin, poudarja družbene vidike takšnih mrež in krepi idejo o kulturni enotnosti v dalmatinski in apulski kulturi Impresso.*

**KLJUČNE BESEDE** – *tehnologija izdelave kamnitih orodij; neolitizacija; Dalmacija; Jadran; izdelki tipa Impresso; tehnika lomljenja pod pritiskom; kultura Castelnovian*

## **Introduction**

In the context of European Prehistory, studies of the lithic industries of the Early Neolithic period in Dalmatia have long been neglected or have been limited to typological aspects (Čečuk 1974; 1976; Müller 1994; Bass 1998). Regarding Northern Dalmatia, only one study, that from the open-air site Crno Vri-  
lo, has been published in detail, but again mostly

focusing on typological observations (Korona 2009). More detailed data is available from Southern Dalmatian cave sites, but the assemblages are small and/or from insecure contexts (Perhoč, Altherr 2011; Forenba-  
her, Perhoč 2015; 2017; Šošić Klindžić et al. 2015). Recently, Zlatko Perhoč and Stašo Forenba-  
her opened new areas of research that consider the

typo-technological aspects together with the raw material economy and modalities of distribution (Forenbaher, Perhoč 2015; 2017).

However, synthesis work on the Early Neolithic assemblages combining both techno-typological aspects (concepts of *schéma opératoire* and *chaîne opératoire*) and the *débitage* economy with raw material economy is still lacking.

Lithic assemblages reflect the intentions of prehistoric knappers and the procedures they performed in their project realization, *i.e.* the choice of raw materials, methods and techniques employed, *etc.* While in some Mesolithic societies (*i.e.* the Early Mesolithic of the Balkans) their conceptual and operative schemes often depend on techno-environmental factors, with the Neolithic the socio-cultural aspects of lithic productions are emphasized (*cf.* Inizan et al. 1999; Perlès 2009).

Therefore, the study of the Early Neolithic chipped stone assemblages not only informs us of the techno-economical needs of the first farmers, but illustrates their social and ideological choices and relations. The strategies of the lithic production can reveal the contacts and interactions between the groups and their social and symbolic conceptions, but can also represent the routes and mechanisms of Neolithisation (Perlès 2009; Forenbaher, Perhoč 2017).

Moreover, in the context of Neolithisation, the study of chipped stone industries is essential to our understanding of the Mesolithic/Neolithic transition. In

contrast to pottery, lithic production is an industry that the last hunter-gatherers and first farmers have in common. It consequently appears the most suitable production to evidence plausible generic links between those two types of societies. Did the first farming communities use the same methods and techniques in their lithic production as the last hunter-gatherers? Do the general *schémas opératoires* differ from Neolithic to Mesolithic sites? Are there notable differences in strategies of raw material procurement from a diachronical perspective?

In the literature dealing with the Mesolithic/Neolithic transition in the Eastern Adriatic, chipped stone industries have served either as evidence of cultural continuity (J. K. Kozłowski 1982; S. Kozłowski 2009; Marijanović 2007; 2009; Korona 2009) or for cultural rupture (Müller 1994). Typology was the only basis for such claims, while the hypothesis for ‘continuity’ was mostly founded on Montenegrin cave assemblages (Crvena Stijena, Odmu) (Benac 1955; Marković 1985; J. K. Kozłowski 1982; S. Kozłowski 2009; Marijanović 2009). Obviously, however, the uncertain stratigraphic contexts of the Montenegrin assemblages cannot be used as one reference database for the whole Eastern Adriatic.

In general, lithic assemblages from Dalmatia reflect the complex strategies of lithic production as seen in the complex economy of raw material and a certain degree of techno-economic specialisation (Forenbaher, Perhoč 2017; Mazzucco et al. 2018; Podrug et al. *in press a*; *in press b*; Kačar 2019). This paper aims to examine the strategies of blade production

**Fig. 1.** Map of the main Dalmatian and Apulian impressed ware sites and the other sites mentioned in text. Framed: study area. Dotted lines: the hypothesized position of coastline during the 6<sup>th</sup> millennium BC (based on bathymetric charts and the presumption that the sea level was -10 to -15m lower than today (*cf.* Surić 2006; Fontana et al. 2014)). Dots: open-air sites, stars: caves. 1 Pokrovnik, 2 Zemunica, 3 Vela spila, 4 Nakovana, 5 Gudnja, 6 Crvena Stijena, 7 Coppa Nevigata, 8 Ripa Tetta, 9 Maseria Giuffredda, 10 Rendina, 11 Pulo di Molfetta, 12 Scamuso, 13 Sušac (background map designed by F. Tessier).



in order to investigate its techno-economic and social aspects. As such it attempts to shed some new light on Neolithisation in the region.

### Materials and methods

This study is based on Neolithic lithic assemblages from some main Impressed-ware sites in the Šibenik and Zadar regions (Northern Dalmatia): Rašinovac, Vrbica, Konjevrate, Crno Vrilo, Tinj and Polje Niže Vrcelja (Fig. 1). All the sites are open-air settlements, but the degree of research differs among them, as well as excavation strategies and methods employed. Konjevrate, Vrbica and Polje Niže Vrcelja were part of rescue excavations where large surfaces were open: c. 487m<sup>2</sup> in Polje Niže Vrcelja, c. 160m<sup>2</sup> in Konjevrate and c. 50m<sup>2</sup> in Vrbica (Brusić 1995; Mendušić 1998; Podrug 2013; Horvat 2015). Systematic excavations were carried on Crno Vrilo, where a total of 550m<sup>2</sup> excavated area has yielded the remains of a Neolithic village with rectangular houses (Marijanović 2009).

Trial excavations were conducted in Tinj and Rašinovac (Chapman et al. 1996; Podrug et al. *in press a*). In the latter only a small surface was open (4m<sup>2</sup>).

Except Vrbica, which lacks the organic material, all the sites were radiocarbon dated (Tab. 1).

All <sup>14</sup>C dates mentioned in text have been recalibrated in OxCal v4.3 (Bronk Ramsey 2009) and Int Cal13 (Reimer et al. 2013). However, some dates and namely those obtained for Tinj should be dismissed, as they show high standard deviation. Radiocarbon chronology ranges from the very beginning of 6<sup>th</sup> millennium calBC to the c. 5400 calBC. The earliest dates, around 6000/5900 cal BC, have been obtained from Rašinovac in Šibenik county. Crno Vrilo and Konjevrate can be placed roughly between 5800 and 5500 cal BC. The youngest dates are obtained from Polje Niže Vrcelja, placing its occupation to the very end of the impressed-ware phase, c. 5500–5400 cal BC. Despite the lack of <sup>14</sup>C dates for the Vrbica assemblage, the presence of one bifacial retouched point, typical for the Danilo phase and Danilo-like sickle insert (Mazzucco et al. 2018), might suggest its affiliation with the later phase of Impressed ware culture.

Following this, it should be noted that the majority of Early Neolithic material studied in this work belongs to the later phase of Impressed ware (from c. 5800 cal BC), while only one assemblage (Rašinovac)

can be dated to the very beginning of the Neolithic in the Adriatic region (c. 6000 cal BC) (Forenbaher et al. 2013; Forenbaher, Miracle 2014; McClure et al. 2014; Podrug et al. *in press*).

However, the Rašinovac assemblage doesn't show any significant difference from the technological and petrological points of view with other, younger assemblages. Moreover, according to available published data, as well as from the author's personal observations, the Early Neolithic assemblages of Southern Dalmatia, dated between c. 6000 to 5500 cal BC, are probably characterized by the same *schéma opératoire*, i.e. the same technology and raw material economy (Bass 1998; Marijanović 2005; Forenbaher, Kaiser 2008; Forenbaher, Perhoč 2015; 2017; Drnić et al. 2018; Mazzucco et al. 2018).

Thus, although this paper deals with the Early Neolithic lithic production of Northern Dalmatia, broader conclusions can be drawn that will concern the whole of Dalmatia.

The question of the origin of the Neolithic chert industries and its place within the discussion of Neolithisation is limited, since the Late Mesolithic sites are absent from the region. The only site in Dalmatia where Late Mesolithic occupation is clearly attested is Vela Spila on the island of Korčula, but the small quantities of collected lithic material do not allow any techno-typological and cultural attribution (Čečuk, Radić 2005; Vukosavljević 2012). However, when discussing the relevance of lithic studies in the Neolithisation process, in order to compare the Impressed ware industries with the previous periods, we refer to the Castelnovian lithic production strategies of adjacent regions (Collina 2009; Binder et al. 2012; Ferrari 2011; Kačar 2019). The Castelnovian techno-complex developed during the 7<sup>th</sup> millennium BC and characterizes the Late Mesolithic lithic assemblages of the central-western Mediterranean, but is absent from Croatia and Greece (Kozłowski 2009; Marchand, Perrin 2017). While its absence from Greece can be interpreted by the early presence of Neolithic colons in this region (from c. 6700 cal BC), its absence from the Croatian littoral (both Dalmatia and Istria) is curious because analogous industries have been found in the neighbouring regions (Italian and Slovenian Karst, Po valley, Montenegro) (Biagi 2003; Turk 2000; Mihailović 2009; Kozłowski 2009; Ferrari 2011; Kaczanowska, Kozłowski 2017; Kačar 2019). We therefore think that the absence of Castelnovian finds along the Croatian coast is due to a lack of research and preservation

Site	Location	County	Stratigraphic Unit	Analysis	Laboratory Nr	BP	cal BC $\pm$ sigma	Material	Comment	Reference
Crno Vrilo	Zekić, Ninski Draševac	Zadar County	B/IX/1 (upper part)	$^{14}\text{C}$	Z-3399	7560	6651	animal bone	not reliable	Marijanović 2009
Crno Vrilo	Zekić, Ninski Draševac	Zadar County	A/IIA/sterile (lower part)	$^{14}\text{C}$	Z-3398	6400	5563	animal bone	not reliable	Marijanović 2009
Crno Vrilo	Zekić, Ninski Draševac	Zadar County	A/IIA/1 (upper part)	AMS	Beta-222405	6500	5561	bone collagen	too young?	Marijanović 2009
Crno Vrilo	Zekić, Ninski Draševac	Zadar County	A/IIA/ sterile (lower part)	AMS	Beta-222406	6820	5803	bone collagen		Marijanović 2009
Crno Vrilo	Zekić, Ninski Draševac	Zadar County	A/IIA/ sterile (lower part)	AMS	Poz-18395	6900	5881	bone collagen		Marijanović 2009
Crno Vrilo	Zekić, Ninski Draševac	Zadar County	A/IIA/1 (upper part)	AMS	Poz-18393	6925	5886	bone collagen	questionable	Marijanović 2009
Tinj	Tinj, Benkovac	Zadar County	I (pit 1)	$^{14}\text{C}$	GrN-15236	6980	6126		high standard deviation	Chapman et al. 1991
Tinj	Tinj, Benkovac	Zadar County	I (pit 2)	$^{14}\text{C}$	GrN-15237	6670	6081		high standard deviation	Chapman et al. 1991
Tinj	Tinj, Benkovac	Zadar County	I (pit 3)	$^{14}\text{C}$	GrN-15238	6280	5624		high standard deviation	Chapman et al. 1991
Polje niže Vrcelja	Vrcelji, Benkovac	Zadar County	trench 1, upper part	$^{14}\text{C}$	Beta-293840	6520	5559	charcoal		Horvat 2015
Polje niže Vrcelja	Vrcelji, Benkovac	Zadar County	lower part	$^{14}\text{C}$	Beta-293835	6480	5529	animal bone		Horvat 2015
Rašinovac	Piramatovci, Bribir	Šibenik-Knin County	SU 3 (upper part)	AMS	PSU-5612, UCIAMS-127394	7060	6001	bone <i>bos taurus</i>		McClure et al. 2014
Rašinovac	Piramatovci, Bribir	Šibenik-Knin County	SU 3 (lower part)	AMS	PSU-6492, UCIAMS-158546	7065	6004	bone <i>capra</i>		Podrug et al. in press a
Konjevrate	Konjevrate, Šibenik	Šibenik-Knin County	trench I, arbitrary layer 1	AMS	PSU-5291, UCIAMS-116203	6655	5630	bone <i>ovis aries</i>		McClure et al. 2014
Konjevrate	Konjevrate, Šibenik	Šibenik-Knin County	trench I, arbitrary layer 3	AMS	PSU-5557, UCIAMS-119838	6175	5038	bone <i>ovis aries</i>	too late for Impressed ware	McClure et al. 2014
Konjevrate	Konjevrate, Šibenik	Šibenik-Knin County	trench III/ arbitrary layer 4	AMS	PSUAMS-1431	6985	5980	bone <i>bos taurus</i>		McClure et al. 2018b
Konjevrate	Konjevrate, Šibenik	Šibenik-Knin County	bb/ arbitrary layer 8	AMS	PSUAMS-1432	6950	5974	mamal bone		McClure et al. 2018b
Konjevrate	Konjevrate, Šibenik	Šibenik-Knin County	bb/ arbitrary layer 7	AMS	PSUAMS-1433	7000	5984	bone <i>Capra hircus</i>		McClure et al. 2018b

Tab. 1. Radiocarbon dates associated with Early Neolithic assemblages of Northern Dalmatia.

factors (the sites could have been submerged due to the Holocene sea-level rise or buried under alluvial deposits).

Lithic analyses have been carried out according to the concepts of *chaîne* and *schéma opératoire*, *débitage* economy and raw material economy (Leroi-Gourhan 1965; Pelegrin 1988; Inizian 1980; Perlès 1980; 1990; 1991; Inizan et al. 1999; Soressi, Geneste 2011). When describing stone tools, the typology established by Didier Binder and further developed by Thomas Perrin is generally used, but in its simplified form (Binder 1987; Perrin et al. 2017). Although the raw material was examined macroscopically by the author according to the protocol established by Bressy in 2003, we are here largely relying on the published and unpublished work of Perhoč (Perhoč 2009ab; Perhoč, Altherr 2011; Forenbaher, Perhoč 2015; 2017; Vukosavljević et al. 2014; Vukosavljević, Perhoč 2017; Vujević et al. 2017; Perhoč, Ruka 2017). However, as his petrographic analysis on the assemblages mentioned in this article is still in progress, the results presented here should be considered preliminary. Our data will soon be correlated for a final publication, and here I take the opportunity to thank Perhoč for allowing me use some of his preliminary results.

### Northern Dalmatia – geographic framework and subsistence strategies

Northern Dalmatia, as a central part of the Eastern Adriatic region, includes Zadar and Šibenik-Knin county, and spreads roughly from the southern edge of the Velebit mountain to the north to Krka River to the south. In the west, the region includes the Adriatic Sea and the Dalmatian islands (from Pag to Zlarin) and, on the east, it spreads to the Dinara mountains which constitute the natural border between Croatia and Bosnia. Unlike the Italian coastline, which is low and accessible, the Croatian coast is well indented and high (the Dinaric mountain range falls abruptly towards the coast, except for

few narrow coastal plains). The relief of Northern Dalmatia is, compared to other parts of the region, less pronounced and characterized by the relative richness of the plains, in particular Ravni Kotari and *poljes* around Šibenik.

Almost all known Dalmatian open-air sites are situated here, on the fertile soils and always close to water sources (Fig. 2).

The region seems to have been rather densely populated during the Early Neolithic, with at least 20 open air-sites identified, the occupational sequence of 11 of which was confirmed by excavations (Horvat 2017; Podrug et al. *in press a*).

There is still one obvious lack of data to inventory the zooarchaeological and archeobotanical record of the Early Neolithic in Northern Dalmatia, although in the present state of research, analysis broadly shows that the economy of the early Neolithic population was dominated by ovicaprines for a combined milk-meat husbandry strategy, and that agriculture is based on emmer, einkorn and barley (Radović 2011; Reed 2015; McClure et al. 2018a).

According to the faunal record, it seems that hunting and fishing played only a marginal role, although lithic kits might indicate this practice, notably with the presence of hunting equipment like trapeze arrowheads. However, trapeze arrowheads could have also been used in warfare or for some other purposes. The paucity of fishing equipment could be explained by the distance of the sites from the larger waterbodies, as well as by the perishability of the osseous material, but it can also reflect cultural choices. In this regard, it is worth mentioning the results from the stable isotope analyses conducted recently on Early Neolithic humans from Zemunica cave (near Split in Southern Dalmatia), which show that the diet of these individuals was completely terrestrial, consisting mainly of domesticated animals (Guiry et al. 2017).



**Fig. 2.** Piramatovac valley viewed from the southeast with position of Vrbica site (encircled). Photo by Emil Podrug.

## The Neolithisation of the Eastern Adriatic

The Neolithisation of the Eastern Adriatic region begins at the onset of the 6<sup>th</sup> millennium and it is associated with the Impressed ware culture. During period, the same culture, with some regional differences in ceramic production which evolved over time, spread on the Italian shore of the Adriatic.

The earliest Neolithic sites of Northern Dalmatia are dated from the beginning of 6<sup>th</sup> millennium. They are thus contemporary with the oldest Neolithic occupations of the Eastern Adriatic. In the light of new radiocarbon dates, Stašo Forenbaher and Preston Miracle (2014) recently revisited their former model of Neolithisation (Forenbaher, Miracle 2005; 2006) arguing that some interactions between local foragers and newcomer farmers (whose presence seems only evidenced in caves) took place all over the Adriatic coast during the beginning of 6<sup>th</sup> millennium and that the real colonization (settlement foundation) occurred about 150 year later (c. 5900–5800 cal BC), moving progressively from the south to the north.

Recent field research conducted in Northern Dalmatia slightly modified this model. The early dates for open-air sites like Rašinovac and Pokrovnik appear to corroborate the simultaneity of cave and open-air settlements (Müller 1994; McClure et al. 2014), and challenge the proposed anteriority of cave sites over open-air sites (Batović 1979; Forenbaher, Miracle 2014; Forenbaher, Perhoč 2017.202). The distinction between cave and open-air sites is purely functional (McClure et al. 2014.1036), whereas only the latter can precisely reflect the Neolithic way of life (Guilaine 2005.60).

Still, the majority of the open-air sites do not belong to the earliest phase of the Neolithic occupation, but are dated a few centuries later, between 5800 to 5400 cal BC.

Moreover, Forenbaher and Miracle reopened the question of the possible west-east direction of colonization (from Apulia to Dalmatia), since the radiocarbon dates obtained for South Italian villages are somewhat older than the Dalmatian ones (Müller 1994.259; Forenbaher, Miracle 2014.238, Forenbaher, Perhoč 2015.66; 2017.202–204). However, as already mentioned, the new dates obtained from Pokrovnik and Rašinovac place the foundation of those villages at the beginning of 6<sup>th</sup> millennium, which sets them as contemporaneous to the South

Italian sites. It must be noted that those ‘early’ dates from Apulia (cf. Rendina, Masseria Giufreda and Pulo di Molfetta), are problematic, as they show large standard deviations and/or are coming from insecure or later contexts (Guilaine et al. 2003.372; Rendina 2007; Collina 2009.52,57; Guilbeau 2010.71). Moreover, all the recently obtained radiocarbon dates from the earliest Neolithic occupations of Apulia are still slightly younger than the Dalmatian ones (Binder et al. 2017).

Thus, if one relies on firm data, the reliable current radiocarbon dates suggest a temporal priority to the Eastern Adriatic open-air sites.

However, considering the latest discoveries in the strategies of raw material procurement, pointing to sources on the Gargano promontory, the possibility of Apulian influences in the Neolithisation process in Dalmatia should not be rejected (Forenbaher, Perhoč 2015; 2017; Podrug et al. *in press a*).

Nevertheless, while the richness of Neolithic sites confirms that that colonization played a major role in establishing a Neolithic way of life, evidence for the presence of last hunter-fisher-gatherers in the Eastern Adriatic is still pretty scarce. In the literature, the open-air site of Lokve is sometimes referred to as Castelnovian (Komšo 2007.66; Mihailović 2009.103; Kaczanowska, Kozłowski 2017.203). However, the related material collected from insecure contexts (see Komšo 2009.292) displays important heterogeneity in the both raw material economy and typo-technology (Kačar 2019).

As already mentioned, thus far, Castelnovian is absent from Dalmatia. Further research is needed in order to demonstrate whether this outlines an historical reality or if this situation is related to some other factors, such as, for example, some shift in the settlement pattern and/or loss of the sites by marine transgression, lack of research, and so on.

## Lithic production strategies in the Early Neolithic of South-eastern Europe and the Central Mediterranean

‘Prismatic blade technology’ or ‘long blade technology’ is often considered to be a part of the so called ‘Neolithic package’, and thus one of the elements that transmits from the Near East to Europe.

Without going into further discussion about the concept of this ‘package’ and its content, one cannot but

notice the sudden presence of long blades in Neolithic contexts all over South-eastern Europe.

In order to obtain blade blanks two main knapping techniques are generally used during the European Neolithic: indirect percussion and pressure flaking.

The technique of pressure flaking consists of applying great force on one precise point on the platform in order to obtain blades or bladelets. Indirect percussion involves the application of an intermediary tool, called a 'punch', which can be made of wood, antler or bone (*Inizan et al. 1999:32*).

The main advantage of pressure flaking and indirect percussion over direct percussion is greater productivity and profitability. They both allow a Prehistoric knapper to maximize their production since they will obtain a considerable number of blades from a single block.

The identification of the two techniques is possible due to experimental work by several archaeologists, like François Bordes, Don Crabtree, Jacques Texier, and Jacques Pelegrin. There are some general morphological criteria that individualized the two techniques (*cf. Inizan et al. 1999; Pelegrin 2012*). Thus, the pressure technique is identified by the regularity and standardization of blade products. This regularity is due to the immobilization of the core and the pressure force that is continuous and intense. Hence, a straight profile, parallel edges and ridges and a constant thickness characterize the blades. On the other hand, blades obtained by indirect percussion are in general larger, but less standardized and characterized by a curved profile. However, as archaeological and experimental examples show, blades obtained by indirect percussion can also be very regular, whereas the pressure flaked blades could show high variation in regularity. Besides, one must bear in mind that experimentation conducted with pressure flaking is much better documented than experimentation on indirect percussion.

Although the concept of pressure flaking was known since the Upper Palaeolithic, the two techniques were widely used in blade production since the Late Mesolithic (*Binder, Perlès 1990; Inizan et al. 1999*). Pressure flaking was widespread during the Late Mesolithic Castelnovian culture in the Mediterranean (*Binder 1987; 2010*). The closest Castelnovian industries to the region, those from Montenegro, are also characterized by pressure flaking (*Kačar 2019*). During the Neolithic, this technique is also common

all over the Mediterranean (*Binder 1987; 2007; 2010; Perlès 1990; 2001; Horejs et al. 2015*) and at least in some parts of South-eastern Europe like Bosnia and Serbia (*I. Jovanović pers. comm.*).

The indirect percussion or 'punch' technique is present during the Late Mesolithic in Southern and Northern Europe (*Allard 2007:219; Perrin 2009. 518; Ferrari 2011*), but it seems marginal in the Castelnovian of Montenegro (*Kačar 2019*). During the Neolithic, it became the common technique for blade production in different regions of Europe. Indirect percussion is well attested in the Early Neolithic Starčevo-Körös culture (*Mateiciucová 2007:701; Šošić-Klindžić, Karavanić 2004:26; Karavanić et al. 2010:15; pers. comm. J. Pelegrin and I. Jovanović, personal observations*). In the Early Neolithic of Bulgaria (Karanovo I-II), it is a common technique for obtaining long blades (*Gurova 2014*). However, this technique was not exclusive for producing long and large blanks, since the Starčevo-Körös assemblages are characterized by bladelets (*Mateiciucová 2007; Šošić-Klindžić, Karavanić 2004; Karavanić et al. 2010; personal observations*). Large butts, sometimes concave, pronounced bulbs together with a certain irregularity of blanks, point rather to the use of indirect percussion.

As demonstrated above, the archaeological evidence shows that the use of so-called complex *débitage* techniques (pressure and indirect percussion) is not a Neolithic novelty, but appears from the Late Mesolithic. However, the almost systematic use of exogenous rocks in this production, as recorded in some parts of the South-eastern Europe, is an element specific to the Neolithic.

The exploitation of exogenous raw materials certainly began in the Mesolithic (or in the final Palaeolithic), as evidenced, for example, by the Melian obsidian which circulates in the Aegean, but unlike the Neolithic, the production on these exogenous rocks does not differ from that of local rocks, since they are both characterized by a simple technical investment (for an expedient production of flakes, see *Perlès 1990; 1991; 2009*).

In Central and Western Europe, so-called 'Carpathian' obsidian and Wommerssom quartzite also appear to circulate over a larger area before the Neolithic (*Mateiciucová 2007; Kozłowski 2009*).

Nevertheless, as claimed by Catherine Perlès (2009. 558), "[...] there is no economy of raw materials,

in the sense of a differential exploitation". These exogenous rocks have therefore been exploited in the same way as the local raw material. Conversely, from the Neolithic, a more 'complex' raw material economy is implemented, and this change in the exploitation strategies of raw materials is linked to social or economic factors (Perlès 1990; 1991; 2009. 558–563).

From the very beginning of the Neolithic (c. 6700–6000 cal BC), several raw material distribution networks were operating in the Central Mediterranean and the Balkans (Fig. 3).

Those networks differ according to the extension of the network concerned, *i.e.* according to the distribution area: some may be considered local and/or regional (for example the 'Marche' cherts or the Northern Bosnian rocks, 'chocolate flints' from Northern Greece, Mont Lessini cherts), and others interregional (obsidian from Melos and Lipari, Gargano cherts). Nevertheless, at this stage, the characterization of these networks is limited and requires more in-depth regional studies. Moreover, the size of the territory alone is not sufficient to distinguish a regional network from an inter-regional one, but other factors, such as geographical constraints, must be taken into account (for example, 'Carpathian' obsidian circulates over an territory of significant size, but geographically this is the relatively easily crossed Panno-

nian Basin). In Figure 3 we have tried to trace these networks, which in our opinion can indicate not only the contacts between distinct geographical groups, but could also illustrate the routes and directions of Neolithization.

In some cases these exogenous rocks of regional/interregional origin ('Silex blond' from Greece, 'Balkan flint'/'white-spotted flint' in the Central Balkans and Gargano cherts in Southern Italy and Dalmatia) have been exploited in a different way than local cherts, indicating a complex form of techno-economic production (Perlès 1990; 2009; Collina 2009; Guilbeau 2010; Forenbaier, Perhoč 2015; Guilbeau, Perlès 2016; Gurova et al. 2016; Kačar 2019).

### Gargano cherts – an important element of Southern Italian and Dalmatian Impressed Ware culture

Recent research has shown that artefacts made from Gargano cherts are recorded at many Early Neolithic sites of Southern Italy (namely from the Northern Apulian Tavoliere region, as well as from Northern Basilicata and Eastern Calabria) and Dalmatia, evidencing that those important source deposits have been used since the very beginning of the Neolithic, from c. 6000 cal BC (Collina 2009; 2015; Guilbeau 2011; 2012; Forenbaier, Perhoč 2015; 2017; Taranini 2016; Mazzucco et al. 2018; Kačar 2019).

**Fig. 3. Illustration of known raw material distribution networks in the Central Mediterranean and the Balkans, during the Early/Middle Neolithic, between c. 6700 and 5000 cal BC (the displayed dates indicate the beginning of distribution in the Neolithic). Dotted lines: maximum extension of the network in the Early Neolithic (light dotted lines with titles in bold represent obsidian distribution networks). A question mark (?) indicates the presence of high quality chert of unknown, but probable exogenous origin. An asterisk (\*) indicate the existence of pre-Neolithic networks (according to Perlès 1987; 1990; 2004; 2009; Komšo 2006; Mateiciucová 2007; Kaczanowska, Kozłowski 2008; Collina 2009; Guilbeau 2010, 2011; Guilbeau, Erdoğan 2011; Šošić-Klindžić 2011; Reingruber 2011; Gurova 2012, 2014; Gurova et al. 2016; Conati Barbaro et al. 2014; Freund 2014; 2018; Šarić 2014; Forenbaier, Perhoč 2015, 2017; Kozłowski, Kaczanowska 2015; Tykot 2014; Dogiama 2018; Starnini et al. 2018; Po drug et al. in press a; background map by F. Tessier).**





The Gargano promontory, covering an area of about 2000km<sup>2</sup>, is situated on the western shore of Adriatic in the vicinity of the Tavoliere plain, where one of the earliest Neolithic sites in Italy were documented.

A large network of at least twenty mining sites have been discovered, mostly located on the north-eastern part of the Gargano promontory (between Vieste and Peschici), whose exploitation was dated from the Early Neolithic to the Early Bronze Age, c. 6000–2000 cal BC (*Di Lernia et al. 1995; Galiberti 2005; Tarantini, Galiberti 2011; Tarantini et al. 2016*). Three geological Gargano formations were exploited by prehistoric miners: the Maiolica, Scaglia and Peschici formations (*Tarantini et al. 2017*). In this region homogenous cherts are abundant, and occur either as large lenticular nodules (Peschici Nummulite platform) or in the form of spherical and irregular nodules (Maiolica and Scaglia) (for details see *Tarantini et al. 2017*).

The Defensola site, situated on the Gargano promontory, is considered to be the oldest mine in Europe. Radiocarbon dates indicate that this underground mine was used at least from c. 5800–5700 cal BC (*Di Lernia et al. 1995.126–130; Guilbeau 2010.51; Tarantini et al. 2017.253*) and many Impressa sherds have been collected from here.

With regard to the current state of research, there is no evidence pointing to the complex exploitation of such cherts (from the primary sources requiring mining activities) during the Mesolithic.

### **The organisation of lithic blade production in Neolithic Northern Dalmatia**

The organisation of lithic production, reflected in the prehistoric knapper's intentions, implies the concept of *schéma* and *chaîne opératoire* as well as the concepts of raw-material economy and *débitage* economy, and thus examines the lithic artefacts, from their extraction to final consumption (*Leroi-Gourhan 1965; Inizan 1980; Perlès 1980; 1990; Soressi, Geneste 2011*).

#### **Raw material procurement**

Due to the pioneering work of Perhoč, systematic geoarchaeological and petrographic investigations of chert outcrops and artefacts were initiated in the region (*Perhoč 2009ab; Perhoč, Altherr 2011; Forenbaher, Perhoč 2015, 2017; Vukosavljević et al. 2014; Vukosavljević, Perhoč 2017; Vujević et al. 2017*).

According to recent research, during the Neolithic the Gargano cherts (and specifically the Maiolica-type cherts of Upper Jurassic–Lower Cretaceous age) were almost exclusively used in the production of blades (*Forenbaher, Perhoč 2015; 2017.193; Mazzucco et al. 2018; Podrug et al. in press a; in press b; Kačar 2019; pers.com. Z. Perhoč*).

Nevertheless, detailed petrographic characterisation and source identification are often problematic, since a thick white patina covers the majority of artefacts (*Forenbaher, Perhoč 2015; 2017; Podrug et al. in press a; in press b; Kačar 2019*). However, that is not the case for the artefacts from Crno Vrilo, as their primary appearance has stayed unchanged. This assemblage shows an important variability in the colour and structure of this Upper Cretaceous chert that might indicate different sources of procurement within the Gargano area, although these claims need to be confirmed by more detailed petrographic analysis.

It is important to note that, despite the existence of the seemingly well-organized network of Gargano chert distribution, the Lipari obsidian does not reach the Dalmatian shore before the Middle Neolithic Danilo culture (*Tykot 2015; Podrug et al. in press b*).

Besides this exogenous chert, the local Dalmatian cherts are also represented but in smaller quantities and almost exclusively evidenced by flakes and debris. The site of Konjevrate seems to be an exception, since local cherts prevail in the assemblage, but its stratigraphy was recently revisited confirming the pre-Neolithic attribution of these industries (*Podrug, Kačar in press*).

#### **Lithic blade production**

From the very beginning of the Neolithic period in the Eastern Adriatic, the lithic production was orientated towards blade production (*Müller 1994; Forenbaher, Perhoč 2015; 2017; Mazzucco et al. 2018; Podrug et al. in press a*).

The regularity of the blade edges and ridges and constant thickness indicate the use of pressure flaking. According to the lithic assemblages under study here, an average prismatic blade would have been around 14.6mm wide and about 3.8mm thick, and its average length around 48.4 ± 22.3mm (Tab. 4). Figure 4 indicates that the *débitage* aimed to produce bladelets and blades between 10 and 16mm wide.

Based on his experiments, Pelegrin has defined several pressure flaking processes related to the width

of the blade blanks (Pelegrin 1988; 2012.468). The wider the blade is, the stronger must be the pressure exerted to detach the blade. Thus different tools were used in order to develop pressure of different intensities, with each tool corresponding to a certain 'mode' (for details see Pelegrin 1988; 2012.468).

Most (60%) of the Early Neolithic blades from our assemblages evidence the use of a long crutch used in a standing position (mode 4, according to Pelegrin), as their width is between 12 and 16mm – and several pieces reach almost 20mm in width (Fig. 4). The best examples of large blades come from Crno Vrilo, where a few blades of impressive dimensions are preserved. The longest complete example measures 156mm (Korona 2009.154). Along with these specimens there are dozens of pieces whose width exceeds 20mm (Fig. 4). According to Pelegrin's experiments, these specimens could not be detached by abdominal pressure alone (mode 4), since the long crutch used in the standing position cannot provide the necessary pressure.

According to traditional experiments, those blades could have been made by indirect percussion or by a more complex pressure mode (mode 5, according to Pelegrin), which consists of the use of a lever device. However, recently, Heredia managed to obtain, in a non-systematic way and with certain difficulties, a few of larger blades (up to 28mm) by abdominal pressure alone, using the crutch with a copper tip in the standing position (mode 4, according to Pelegrin; <https://www.youtube.com/watch?v=5kvgaEH-Ll0>).

While pressure flaking characterizes the Dalmatian blade production, the use of indirect percussion is harder to demonstrate. However, we think that for some specimens, and especially those detached in order to repair the knapping surface (Pl. 2.1–4), the use of indirect percussion cannot be ruled out. On the other hand, the regularity and straightness of some blanks and their constant thickness point instead to the use of lever pressure (mode 5, according to Pelegrin; Pl. 1.1,2,4). The use of lever pressure is usually suggested for the production from later periods, for example, the Chalcolithic big blades from Karanovo V-VI (Manolakakis 1994). However, such broad blanks are reported since the Early Neolithic in Southern Italy (Guilbeau 2011; Collina 2015) and in Greece (Perlès 1990; Guilbeau, Perlès 2016).

Although the blade cores are absent from the assemblages, the morphology of the blade blanks can in-

dicate their form. They were of cylindrical or sub-conical shapes and *débitage* was always unipolar. The proximal parts of the blades (butts) indicate that the preparation of the striking platform was not systematic (butts are mostly plain and compose 45% of the assemblage, followed by linear with 25%), but the overhangs were carefully removed.

Except in Crno Vrilo, lithic finds are scarcely represented in the Dalmatian Early Neolithic assemblages, making the reconstruction of *schéma* and *chaînes opératoire* somewhat difficult. However, it seems that the Dalmatian assemblages display always partial *chaînes opératoires*, i.e. some technical stages are always missing. Indeed, as already mentioned, the blade cores are always absent while the scarcity of cortical pieces, especially the large and thick ones pointing to decortication, trimming and shaping of the cores, implies that the first stages of reduction occurred somewhere else.

Nevertheless, in the assemblages we studied, at least for some sites, there are some elements pointing to the possibility of *in situ* production. The presence of flakes, cortical flakes and debris, and specifically of technological pieces as core tablets, crested blades, overshot blades and core renewal flakes and blades, could indicate the local production of blades (Tab. 2).

The presence of flakes (especially those bearing laminar negatives on the dorsal side) indicates *in situ* production, but one must keep in mind that pressure flaking produces few flakes. In this, the flakes are usually produced during the first stages of *chaîne opératoire*, i.e. core preparation, while small corrections of *débitage* surface/striking platform are most often realized by detachments of thin laminar flakes or small bladelets (Pl. 1.15). The presence, although rare (only 13 pieces from Crno Vrilo assemblage) of flakes bearing laminar negatives on the dorsal side, but which seem not to have been detached in order to rejuvenate the core, might indicate that, after blade production, the exploitation of the cores continues in order to obtain flakes. These flakes, as well as those made of local cherts, could suggest an *ad hoc* or expedient production, with the expedient products being those that "have been manufactured, used, and discarded over a relatively short time period" (Binford 1977). If this was a case, we can consider that the Early Neolithic people from Dalmatia were acquiring (more or less prepared) cores, and not exclusively finished semi-products. We have noted at least three flake cores on Gargano chert (Tab. 2; Pl. 1.16).

However, we cannot conclude that all the blades were produced *in situ*. While this may be suggested for blades obtained by abdominal pressure flaking (mode 4), for large blades ( $\geq 20$  mm), and especially if we consider that they were produced by lever pressure, the introduction as finished semi-products could not be ruled out. Following criteria established

by Perlès (1990.27; 2001.208) the lever pressured blades suggest high technological investment and obvious socio-economical specialization. Those blades must have been produced by specialized, well-trained knappers possessing the necessary equipment and who invested time in order to obtain the important knowledge and know-how needed for mastering the

	Superior chert Gargano	Mediocre local chert	Thermally altered	Patinated./indeterm./other	Total Blanc
<b>Tinj-Podlivade</b>	Blades	16		2	18
	Cortical blades	4			4
	Core renewal blades	4			4
	Flakes	35	1	4	40
	Cortical flakes	4			4
	Core renewal flakes	4			4
	Cores				
	Debris	21	2	3	26
	Small flakes ( $\geq 1$ cm)	1			1
	Tested blocs				
<b>Total</b>	<b>89</b>	<b>3</b>	<b>9</b>	<b>101</b>	
<b>Rašinovac</b>	Blades	11		1	13
	Burin spalls	1			1
	Core renewal blades	1			1
	Flakes	12	12	1	27
	Cortical flakes		4		6
	Core renewal flakes	3			4
	Cores		1		1
	Debris	5	10		17
	Small flakes ( $\geq 1$ cm)				
	Tested blocs				
<b>Total</b>	<b>33</b>	<b>27</b>	<b>2</b>	<b>8</b>	
<b>Vrbica</b>	Blades	40			40
	Cortical blades	9			9
	Core renewal blades	4		1	5
	Flakes	24		3	27
	Cortical flakes	3			4
	Core renewal flakes	6			6
	Core	1	1		2
	Debris	2	3		6
	Small flakes ( $\geq 1$ cm)				
	Tested blocs				
<b>Total</b>	<b>89</b>	<b>4</b>	<b>6</b>	<b>99</b>	

	Superior chert Gargano	Mediocre local chert	Thermally altered	Patinated./indeterm./other	Total Blanc
<b>Pojje nize Vrcljeja</b>	Blades	10		2	9
	Cortical blades	1			2
	Core renewal blades	3			1
	Burin spalls				1
	Flakes	30		7	15
	Cortical flakes	4			4
	Core renewal flakes	10			7
	Core	1			1
	Debris	25		5	20
	Chips	1	1		3
Tested blocs					
<b>Total</b>	<b>86</b>	<b>3</b>	<b>14</b>	<b>62</b>	
<b>Crno Vrilo Sector A</b>	Blades	200		29	26
	Cortical blades	14		1	2
	Core renewal blades	10		2	3
	Burin spalls	21			1
	Flakes	405	82	79	48
	Cortical flakes	47	21	9	6
	Core renewal flakes	135		23	7
	tablet	9	2	1	
	Core	1	10	1	
	Debris	96	25	38	21
Small flakes ( $\geq 1$ cm)	32			4	
Tested blocs					
<b>Total</b>	<b>970</b>	<b>141</b>	<b>183</b>	<b>118</b>	
<b>Konjevrate 88-90 campaign</b>	Blades	12	34		2
	Cortical blades	1	6		
	Core renewal blades	3	13		1
	Burin spalls		3		
	Flakes	24	228	11	44
	Cortical flakes	3	74	4	9
	Core renewal flakes	8	66	3	7
	Cores and fragments	1	67		4
	– of which for blades		18		
	Debris and natural pieces	2	155	7	16
Small flakes ( $\geq 1$ cm)					
Tested blocs		5			
<b>Total</b>	<b>54</b>	<b>651</b>	<b>25</b>	<b>83</b>	

**Tab. 2. Lithic assemblage breakdown by main raw material groups and technological categories (simplified). The group ‘patinated, indeterminate, other’ clusters the raw materials which could not be identified due to heavy patina or raw material types for which only a few pieces have been found. For this paper different types of local/regional cherts from Konjevrate were regrouped together as ‘local cherts’ since, according to new excavations, these industries are pre-Neolithic. The technical group ‘core-renewal flakes’ clusters flakes testifying to blade *débitage* (elements of reparations and flakes with blade’s negatives).**

core preparation as the technologically most demanding part of the *chaîne opératoire*.

But is it possible to demonstrate that one population of blades (and namely the 'large' ones) were introduced as finished semi-products while others were produced *in situ*?

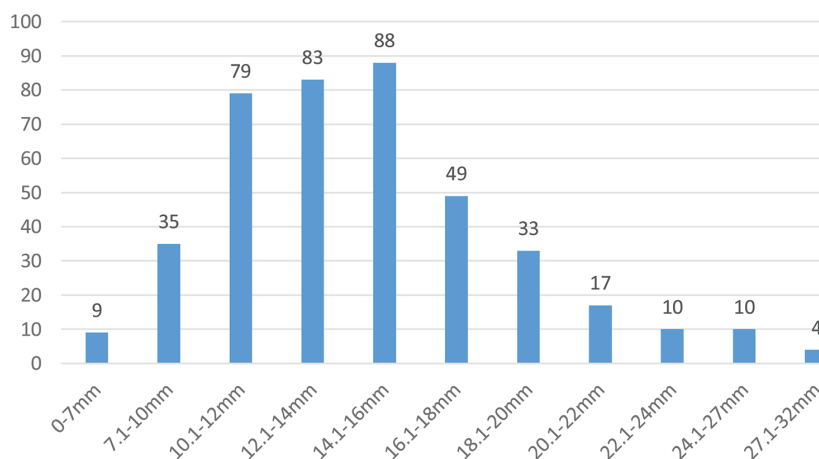
For example, in the Crno Vrilo assemblage cortical and core-renewal blades, *i.e.* pieces that might indicate *in situ* production, are represented with 32 pieces, whereas the width of eight specimens exceeds 20mm

(Fig. 5). Two different hypothesis can be proposed to explain the presence of those specimens. According to the first, the production occurred *in situ* and those specimens point to the beginning of blade *débitage* or to the core renewal (technical pieces). The second hypothesis implies that the production occurred somewhere else (and not on the site) and that the blades that we consider today as 'technical' were also circulating as finished products. This was sometimes observed in other Neolithic contexts, like in the Chaséen of Southern France. Here the regular presence of core renewal blades suggests that the robustness of blanks is sought more than their regularity (Léa 2004.135, 147, 164, 169). Besides, in the Crno Vrilo assemblage six specimens that refer either to cortical or core renewal blades (including two 'larges' ones) are retouched and/or glossy, while seven others (including two 'larges' ones) have very worn edges, probably indicating their use. Moreover, use-wear analysis of the harvesting techniques on the Dalmatian impressed ware assemblages has shown that the different types of blades and bladelets (central, cortical and technical) have been intentionally segmented for use as sickle elements (Mazzucco et al. 2018).

On the other hand, and since we consider that for some technical pieces the use of indirect percussion cannot be ruled out, it is possible that some large blades were produced *in situ* while others (made by lever pressure flaking) could have been introduced as finished semi-products. Future research is needed to clarify the matter.

### Tools

With the introduction of farming, the technical needs of prehistoric societies changed, as witnessed in the



**Fig. 4. Distribution of the impressed ware blades according to their width (Rašinovac, Vrbrica, Polje niže Vrcelja, Tinj-Podlivade, Crno Vrilo, Konjevrate). Only blades on supposed Gargano cherts were counted.**

lithic tool assemblages. The lithic *débitage* was now orientated towards blade production in order to obtain long, regular and thin blanks that can be hafted onto the wooden or bone handles as sickle implements. The traces of use and the dullness of once sharp edges indicate that the majority of blades were used blank. The intensive use of blank blades in various activities could produce non-intentional retouch. For that reason, exhaustive typological analyses of Neolithic lithic assemblages are not necessary, but a combined typo-functional approach is needed.

Impressed ware assemblages from Northern Dalmatia indicate that the tools are mostly made on blades (Tab. 3). In most cases (46%) the retouches were not carefully made and the majority of tools can be regrouped as 'pieces with irregular removals'. Other tool groups can be divided as follows: blades with continuous semi-abrupt retouches (11%), blades and bladelets with abrupt retouches (less frequent 6%), drills and 'becs' (pointed blades with abrupt and semi-abrupt retouches: 7%), truncations (2%), bitruncations and geometrical trapezes (6%, almost exclusively symmetrical, with no use of the microburin technique), and burins and burin spalls (almost only evidenced in the Crno Vrilo assemblage, where it represents 19% of all tools). Glossy blades are well represented in almost all assemblages (33% of all tools). In Crno Vrilo, for example, 21% of all blades from sector A are characterized by a so-called 'sickle-gloss', although their presumed function is yet to be characterized.

The notched blades, the typical tools of Castelnavian assemblages, with notches resulting from a voluntary

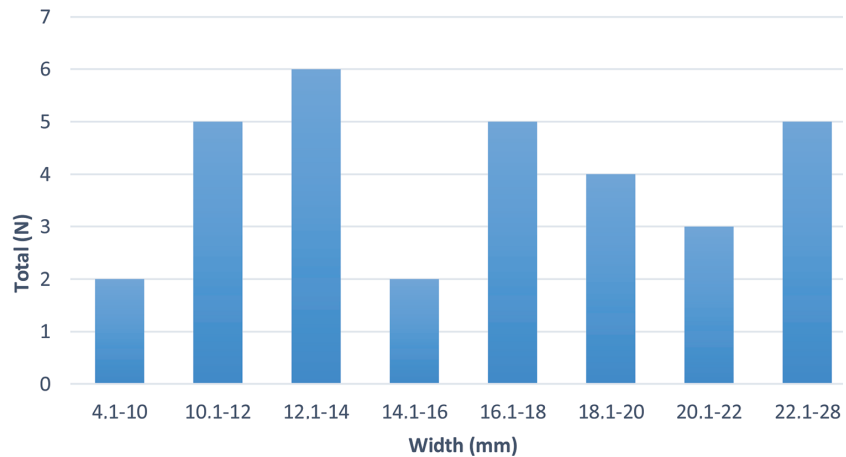
retouch (Gassin et al. 2013), are almost completely absent from Early Neolithic lithic assemblages. On the other hand, the production of trapezes continued during the impressed ware phase, and these bitruncated blade fragments are represented with at least 14 pieces (Tab. 3). However, the Castelnovian trapezes are usually made with the microburin technique and are symmetrical, whereas the Early Neolithic ones do not use this technique and are less standardized as they generally come in various forms and shapes.

Tools made on flakes will not be discussed here, but it can be stated that flake assemblages consist mainly of expedient tools characterized by retouched flakes, scrapers and splintered pieces.

**Early Neolithic lithic production and its relevance to the Neolithisation of the Eastern Adriatic**

From the very beginning of the Neolithic period in both Dalmatia and Apulia, the blade production is characterized by pressure flaking on Gargano cherts (Collina 2009; 2015; Guilbeau 2010; 2011; Forenbaher, Perhoč 2015; 2017; Mazzucco et al. 2018; Podrug et al. in press a; Kačar 2019).

Indirect percussion seems to be used to a much lesser extent and perhaps mainly for repairing the knapping surface or detaching the blades, which would have been too difficult to detach by pressure (Collina 2009; 2015; Kačar 2019).



**Fig. 5. Cortical and technical blades from Crno Vrilo: frequency of blade widths.**

As we have seen, both techniques are known from the Late Mesolithic, but the Early Neolithic lithic production is characterized by more complex procurement strategies, as evidenced in the development of sophisticated raw material economy (Binder 1987; Perlès 1990; 1991; 2009; Allard 2007.219; Perrin 2009: 518; Perrin, Binder 2014; Kačar 2019).

There is no evidences of complex mining during the Mesolithic, neither on the Italian nor Croatian sides of the Adriatic. It is true that the Mesolithic sites and specifically those belonging to its late phase are rather scarce in the Adriatic region, but even where the Castelnovian is surely attested (Uzzo, Latronico, Edera, Crvena Stijena, Odmut) there are no indications of complex strategies involving interregional networks of raw material procurement (Collina 2009; Mihailović 2009; Kačar 2019). Instead, the production of blade blanks relies on local sources of procurement, such as pebbles of small to medium size.

The dominance of Gargano cherts in Dalmatia and Apulia assemblages reinforces the idea of cultural unity under the (Italo-Dalmatian) impressed ware

	Crno Vrilo	Rašinovac	Vrbica	Tinj	Vrcelji	Konjevrate Gargano	Konjevrate other	TOTAL	%
Pieces with irregular removals	72	4	12	5	3	4	3	103	46
Notched pieces	4		1					5	2,2
Pieces with abrupt retouch	8	2				1	2	13	5,8
Pieces with semi-abrupt retouch	13		2		3	1	6	25	11,2
Borers and drills	14	1						15	6,7
Truncations	4	1						5	2,3
Bitruncations	8	1		4	1			14	6,3
Burins and burin spalls	29	1			2		3	35	15,6
Scrapers	3		3				3	9	4
Total tools on blades	155	10	18	9	9	6	17	224	100
of which glossy blades	61	1	6	2	2	1		73	32,5

**Tab. 3. Tools on blades: typological breakdown.**

		no.	Length (mm)	Width (mm)	Thickness (mm)
Early Neolithic Impressed Ware	Rašinovac	no.	1	14	14
		Minimum	37,6	7,1	1,6
		Maximum	37,6	24,5	5,9
		Average	37,6	13,3	3,6
		SD		4,6	1,1
	Vrbica	no.	6	54	54
		Minimum	31,9	6	1,7
		Maximum	71,8	24,3	10,6
		Average	55	15,2	4,3
		SD	17,4	3,7	1,9
	Crno Vrilo (Sector A)	no.	33	280	287
		Minimum	28,8	4,1	0,9
		Maximum	132,5	27,8	8,5
		Average	50,9	14,1	3,7
		SD	21,5	5,1	1,3
	Tinj-Podlivade	no.	2	26	26
		Minimum	9,1	4,1	2,3
		Maximum	84,6	31,5	7
		Average	46,9	16,8	4,1
		SD	53,4	6,1	1,4
Polje nize Vrcelja	no.	7	28	28	
	Minimum	17,3	5,5	1,8	
	Maximum	50,3	19,3	8,6	
	Average	34,2	12,8	3,7	
	SD	10,7	3,3	1,7	
Konjevrate (campaign 1988-1990)	no.	1	15	15	
	Minimum	36,4	6,9	1,6	
	Maximum	36,4	26,3	8,3	
	Average	36,4	14	4	
	SD		4,2	1,9	
All sites	no.	50	417	424	
	Minimum	9,1	4,1	0,9	
	Maximum	132,5	31,5	10,6	
	Average	48,4	14,6	3,8	
	SD	22,3	4,6	1,4	

**Tab. 4. Blades and bladelets metric data. The length was measured only for complete specimens.**

ceramic style. The Gargano network spread over South Italy and Dalmatia at the same time, and since the very start of the 6<sup>th</sup> millennium BC (Collina 2009; 2015; Guilbeau 2010; 2011; Forenbaher, Perhoč 2015; 2017).

This date points to the very beginning of the Neolithisation of the whole Adriatic region. The presence of Gargano cherts in Eastern Adriatic assemblages raises many questions, especially why and how this raw material arrived in Dalmatia. Was it necessary because of the lack of good quality raw material or

the lack of (locational) knowledge? Or was it a choice due to the social and/or symbolic value of exogenous material?

First of all, according to Perhoč's research there are no comparable (by quality and nodule size) cherts in the Dalmatia, nor in the adjacent regions (Perhoč 2009ab; Perhoč, Altherr 2011; Forenbaher, Perhoč 2015; 2017.205; Vukosavljević et al. 2014; Vukosavljević, Perhoč 2017; Vujević et al. 2017; Podrug et al. *in press a*; *in press b*)<sup>1</sup>. This implies that Gargano cherts were a rare good. In this sense, the preference for Gargano cherts in Dalmatia can be interpreted by a relative poverty of raw material suitable for complex pressure flaking (Forenbaher, Perhoč 2017.204–205; Mazzucco et al. 2018; Kačar 2019). However, this does not imply that the Gargano chert distribution has only an economic (utilitarian) role and thus the social aspects of such networks cannot be neglected (Perlès 1990; 2001; 2007; 2009; Forenbaher, Perhoč 2017.206; Kačar 2019). On the contrary, the hypothesis of a cultural choice, revealing a social rather than a technical logic (Perlès 2009), must be privileged. Or, as Forenbaher and Perhoč recently concluded “*Perhaps the true value and purpose of the trans-Adriatic exchange of Gargano cherts was to maintain social networks that linked the small farming communities scattered around the Adriatic shores and islands*” (Forenbaher, Perhoč 2017.206).

According to the same authors, the existence of a Gargano network of distribution from the very beginning of the 6<sup>th</sup> millennium might hint to the West-East direction of Neolithisation (from Apulia to Dalmatia), supporting the hypothesis that migration played an important role in spread of farming (Forenbaher, Perhoč 2017.204).

In this sense the domination of Gargano cherts in the southern Dalmatia as documented in Nakovana cave was interpreted as indicating that the early Neolithic occupants of the cave were recent arrivals, not yet possessing the necessary locational knowledge (Forenbaher, Perhoč 2015.66; 2017.204).

However, although these claims sound plausible, one should keep in mind that reliable current radiocarbon dates show no temporal priority of Italian sites and that many data points are probably lost due to the Holocene sea-level rise.

<sup>1</sup> However, according to Perhoč's publication (2009b.48, Fig. 2), one can note the existence of good-quality chert of non-negligible size (c. 10cm) in southern Dalmatia (Stračinčica, Vela Luka, Korčula).

In order to understand the nature of social interactions between western and eastern shores of Adriatic which might illustrate the alternative routes of Neolithisation, it is necessary to see in which form Gargano cherts arrived in Dalmatia (as finished semi-products or as blade cores) and how they were distributed (by direct or indirect procurement?).

Unfortunately, we have seen that, according to the current state of research, it is not clear in which form Gargano cherts reach Dalmatia. However, unlike Forenbaher and Perhoč (2015; 2017), who concluded that the Gargano blades arrived as finished semi-products, we think that the presence of some elements pointing to blade production *in situ* might also indicate the acquisition of cores, *i.e.* blade blanks were not exclusively imported.

This implies that the *chaines opératoires* of the Dalmatian and South Italian assemblages do not differ substantially, since the Gargano cherts were introduced into the Italian sites as partially worked blocs/cores in the initial phase or finished blanks, and never as raw materials (Collina 2009; Guilbeau 2010; 2011).

It can thus be presumed that the first phases of reduction (decortication and trimming) were conducted near or inside the mines (Di Lerna et al. 1995; Tarantini et al. 2016). The shaped blocs, or even more or less finished cores, could then be distributed over the land and sea. This preparation would facilitate transportation (since the merchandise would have been less heavy) and at the same time ensure the quality of the blocs (*cf.* Perlès 1990.27).

But how were the cherts further distributed? As already mentioned, all the southern Italian assemblages that have been studied with regard to the raw material economy, and even those situated closest to the Gargano mines (Ripa Tetta) or closest to the littoral (Scamuso), lack any evidence of primal reduction (Collina 2009; 2015). Following this and taking into account the important presence of Gargano artefacts at the Crno Vrilo site, a simple down-the-line distribution (Renfrew 1984) should be ruled out.

Besides, the long-distance procurement that requires navigation skills and some complex logistical organisation provides more supports for the idea of trade than direct acquisition (Perlès 1990.17–23; 1992.116).

It is therefore reasonable to assume that the Gargano mines were held and exploited by a limited group

of specialist who controlled the chert distribution as well (Tarantini et al. 2016).

If the chert was distributed in the form of more and less prepared cores, then this implies that the most demanding part of the *débitage* (core preparation) occurred out of the consumer sites. The consumer sites would then receive prepared cores and only needed to detach the blades. This final task – blade detaching – is actually the easiest part of pressure flaking *débitage* (Binder, Perlès 1990.266; Perlès 2007.57; Abbès 2013).

However, we cannot exclude the possibility of intermediary site(s) where the blades were produced for trade. One part of Gargano artefacts was probably circulated as finished products and the lever pressured blades could have been traded this way (Collina 2009; 2015; Forenbaher, Perhoč 2015; 2017; Mazzucco et al. 2018; Kačar 2019). Those sites could have been located on the coast and thus today would be submerged.

The blades manufactured with lever pressure seem to be present in Dalmatia since the very beginning of the Neolithic. They are reported at the oldest levels of Pokrovnik, dated to *c.* 6000 cal BC (Mazzucco et al. 2018). The technique of lever pressure is undoubtedly a Neolithic innovation: it is recorded in a few Neolithic contexts, but never earlier (Pelegrin 2006; Guilbeau, Perlès 2016.3).

To sum up, although the size and the means of the Gargano chert distribution network and its relevance to the Neolithisation dispersion routes have yet to be solved, it is clear that this complex economy of raw material reflects social choices that are specific to the Neolithic.

Moreover, even though the pressure blade flaking technology emerged in the Balkans during the 7<sup>th</sup> millennium, as witnessed in the Montenegrin Late Mesolithic Castelnovian industries (with the blank size pointing to the use of a short crutch, mode 3, according to Pelegrin 1988; 2012), at the onset of Neolithic period more complex modes (modes 4 and 5 according to Pelegrin 1988; 2012) of pressure flaking were developed in connection with a new inter-regional procurement network centred in the Gargano area. It thus seems that we may be dealing with two distant phenomena of probably different origins. The origin of Castelnovian pressure blade production might be in North Africa (Marchand, Perin 2017), whereas impressed ware pressure blade production is closely connected to processes of Neo-

lithisation. The latter shows great connections with Italian impressed ware industries and Greek Early Neolithic industries, both in complex raw material procurement strategies and production techniques, and might thus originate from the Near-East (Turkey or Levant) (Perlès 1990; 2001; Binder 2007; Guilbeau 2010; 2011; 2017; Guilbeau, Perlès 2016; Horejs et al. 2015). In other words, the Early Neolithic blade production of Dalmatian impressed ware should be considered as integral part of the Neolithic package, showing no connections to the Castelnovian or any other Mesolithic lithic traditions.

## Conclusion

Interactions between the eastern and western shores of the Adriatic seemed to have maintained the Neolithisation process in this part of Mediterranean: the importation of Gargano cherts in Dalmatian lithic assemblages parallels the expansion of the Impressed

ware culture and the new type of economy, based on subsistence production. The beginning of the Neolithic period in Dalmatia is thus characterized by profound economic, technical, social and cultural changes that also affected lithic assemblages, since the earliest impressed ware lithic production shows no links to the previous periods.

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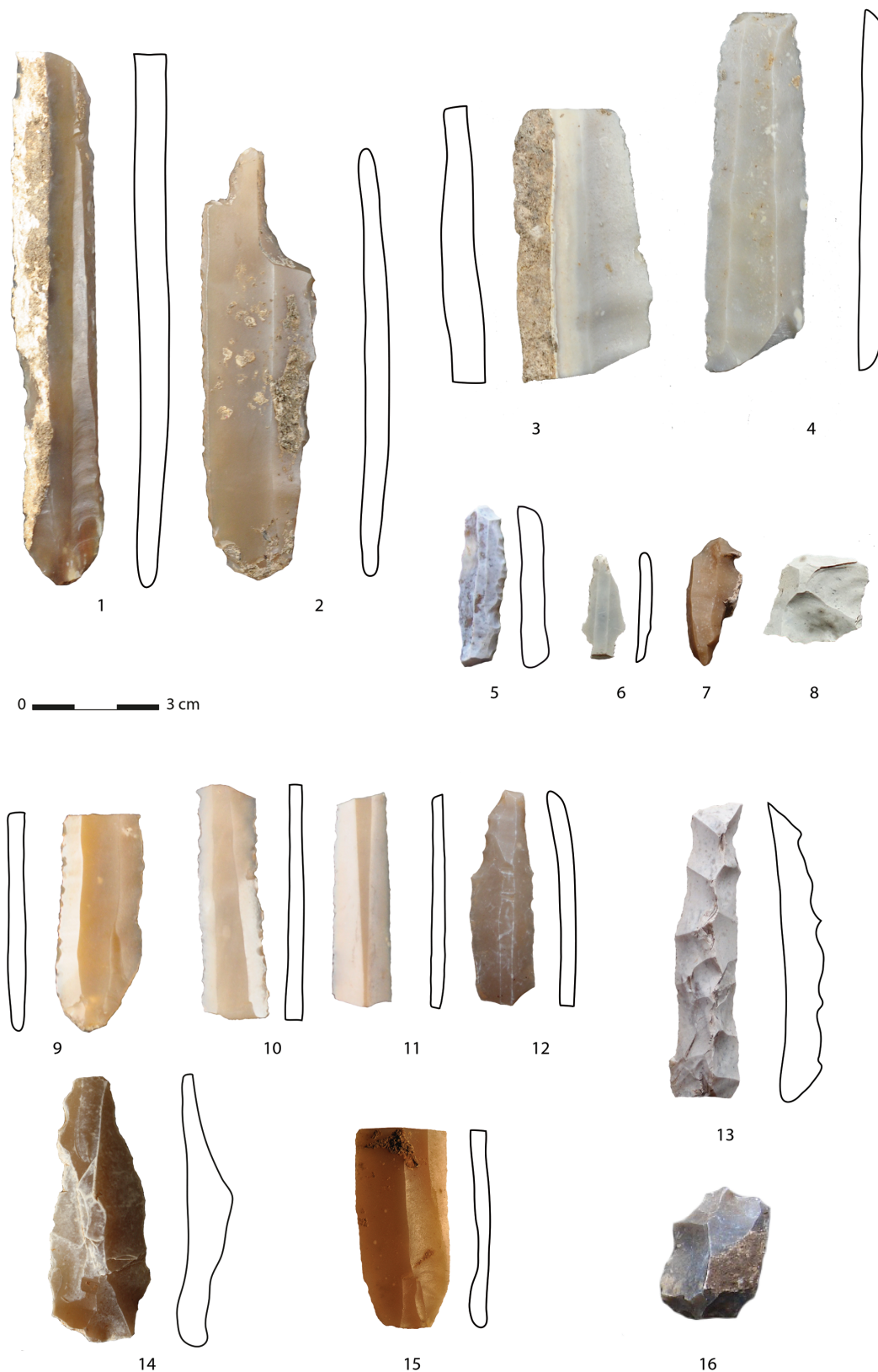
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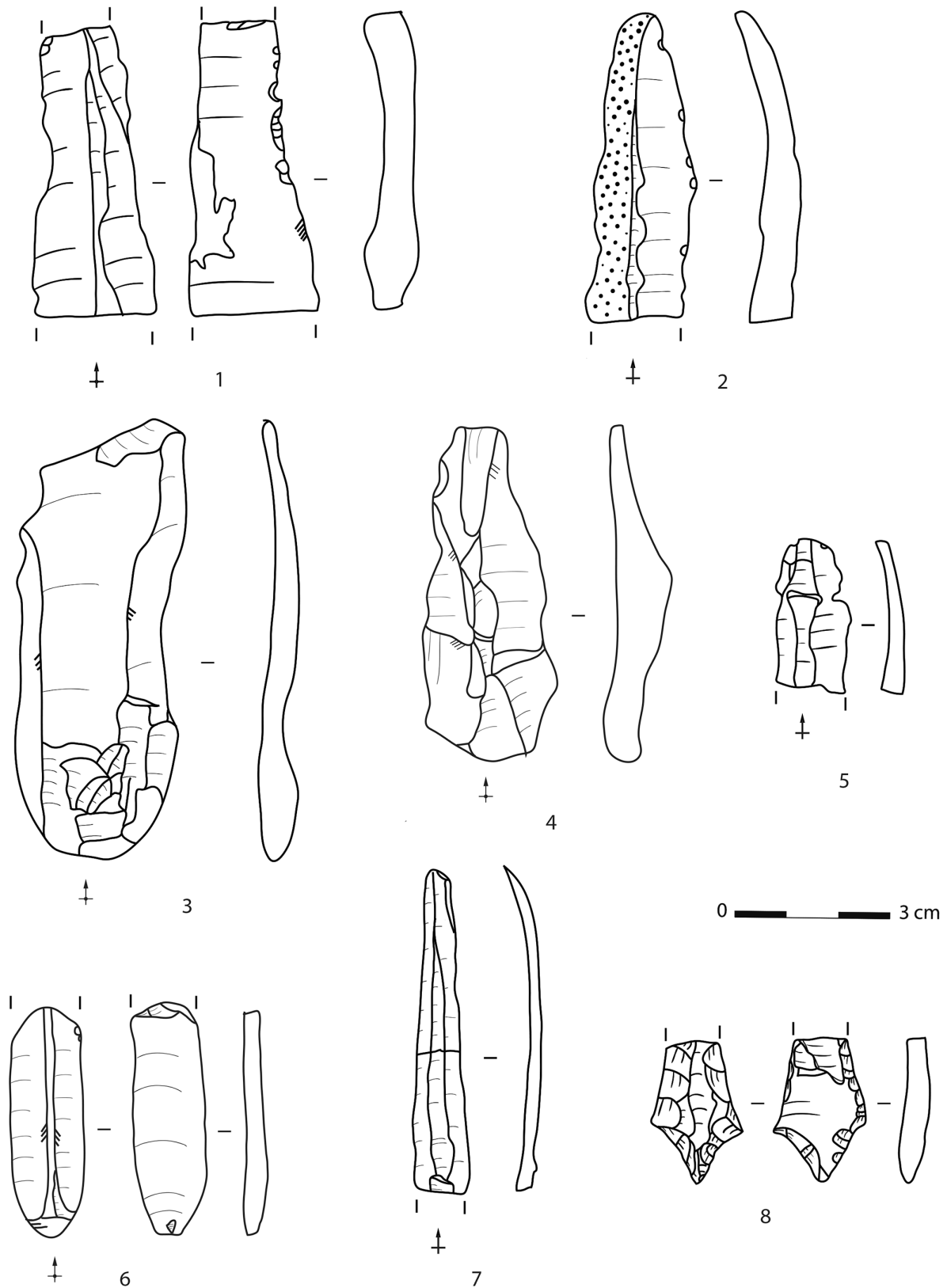
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**Pl. 1. Early Neolithic lithic assemblages from Northern Dalmatia. 1-4, 9-11,15 Crno Vrilo: lever pressured blades (1-2 and possibly 3-4) and pressure flaked blades, mode 4 (9-12, 15); 5, 6, 8 Rašinovac blades and core renewal flake (core tablet); 7, 13 Vrbića: core renewal flake (core fragment) and crested blade; 12, 14 Konjevrate: blade and crested blade; 16. Vrbića flake core. N. 1, 2, 5 and 12 are retouched (1 notched bladed, 2 burin, 5 blade with abrupt retouch, and 12 borer) and 9-11 are glossy. All artefacts are on presumed Gargano flint.**



**Pl. 2. Early Neolithic blades from Northern Dalmatia. Blades testifying to core renewal (1, 3, 4, 5) and cortical blade (2); 1- 4 (1, 2 Vrbica; 3 Tinj; 4 Konjevrate) are probably made by indirect percussion and 5 (Rašinovac) probably by direct percussion. Pressure flaked blades: 6 Konjevrate and 7 Polje Niže Vrce-lja. Pressure flaked bifacial point from Vrbica (8). All artefacts are on presumed Gargano flint.**