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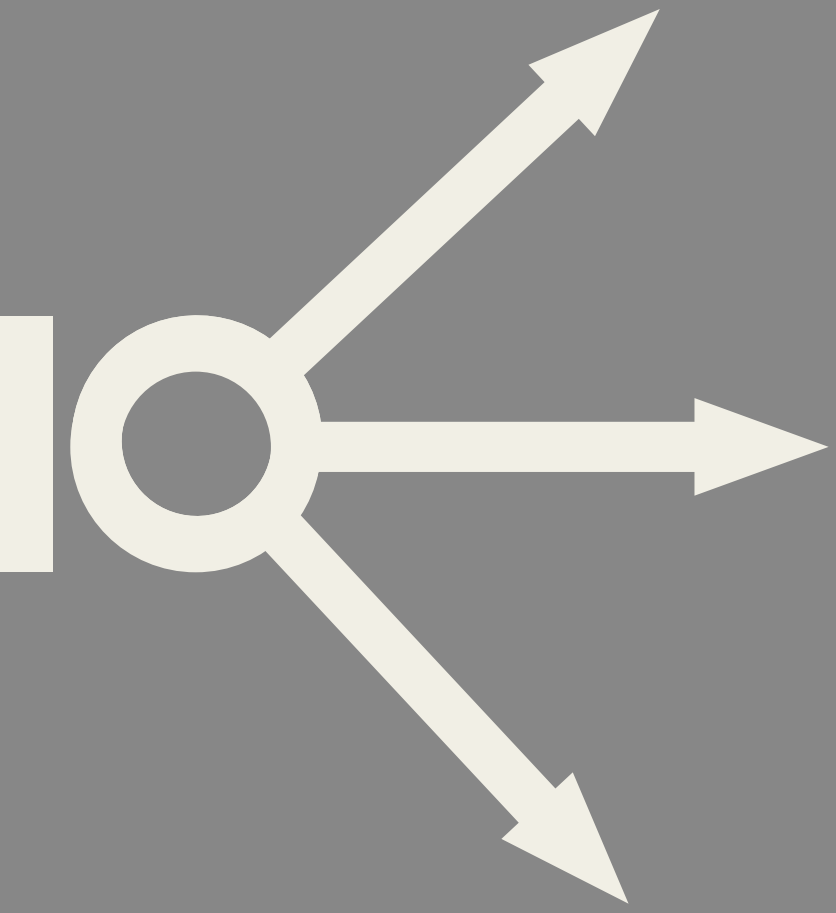
METHODOLOGY & ARCHAEOMETRY

Zagreb, 1st – 2nd December 2022



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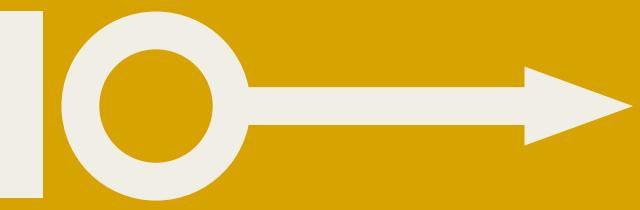

Content

Sickle Gloss on Artefacts recovered at the Galovo Site in Slavonski Brod and the Dužine Site in Zadubravlje

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This paper discusses finds of knapped chert from the Galovo site in Slavonski Brod and the Dužine site in Zadubravlje on which functional analysis identified sickle gloss. The two sites are 15 km apart, both located in the proximity of Slavonski Brod in the Brodska Posavina region [the Sava River basin in the Slavonski Brod area]. The Starčevo horizon of the Galovo site has been dated to 6100 to 5000 cal BC, while finds recovered from the ploughed layer and immediately beneath it are attributed to a later Late Bronze Age horizon of the Barice-Gređani group. The Zadubravlje site corresponds to the Starčevo Culture and is dated from 6000 to 5000 cal BC. Various phases of the formation of sickle gloss were identified on 19 blades, blade fragments or blade tools from the Galovo site, and a truncated bladelet and a flake from the Zadubravlje site. The distribution of gloss on individual specimens at these sites exhibits the characteristic appearance of harvesting tools.

Keywords: *Neolithic, agriculture, use-wear analysis, sickle gloss, Starčevo Culture*

Introduction

The early neolithic Starčevo Culture is a part of the Starčevo-Körös-Criş cultural group, which encompasses the Proto-Sesklo Culture, the Anzabegovo-Vršnik Culture, and the Čavdar-Kremikovci-Karanovo Culture (Minichreiter 2007: 14). Its distribution over a vast area as well as an insufficient number of explored settlements institutes problems in chronology (Šošić Klindžić and Hršak 2014). The settlements are mostly single-layered, and chronologies are usually based on decorated pottery and painting on pottery as well as on smaller geological areas (Šošić Klindžić and Hršak 2014). The beginning of the neolithic in the Brodska Posavina region is represented by Starčevo Culture. For Starčevo Culture in Croatia the chronology of S. Dimitrijević, later modified by K. Minichreiter, is used (Minichreiter 2007: 14).

Functional analysis of finds exhibiting sickle gloss is important for the interpretation of neolithic archaeological material. Sickle gloss appears on artefacts used to cut silica-rich plants, such as domesticated cereals and other grasses, bulrush, and marsh-elder (Vaughan 1985: 35-37). Highly developed gloss is visible to the naked eye while observing less pronounced gloss requires the use of a microscope. The presence of macroscopically inferred gloss must be confirmed by microscopic analysis, because gloss visible to the naked eye may be the result of contamination with present-day materials, such as adhesive applied when assigning call numbers, natural processes that acted on a tool, or the result of the use of a tool on other materials as well as post-depositional surface modification (PDSM). Microscopic analysis can rule out other factors that may have led to its formation.

This paper discusses the examination of knapped lithic material and the performance of microscopic analysis of use-wear traces of finds recovered from the Galovo site in Slavonski Brod and the Dužine site in Zadubravlje to determine the activities that were performed at these sites. In prehistoric and later periods, the selected sites - situated in the Brodska Posavina region (the Sava River basin in the Slavonski Brod area) - were one of the more vital hubs of transport routes. The eastern settlement in Slavonski Brod was situated at Osječka street, within the grounds of the brickworks, on the Galovo land plot, and was discovered in 1995 (Minichreiter 2007). The archaeological site at Dužine in Zadubravlje has been known since 1989 and lies 15 km from Galovo. Alongside Galovo and Dužine there are other Starčevo sites in Slavonski Brod (Minichreiter 2007). The vicinity of multiple contemporaneous settlements is characteristic of the Starčevo Culture (Minichreiter 1992a: 37; Šošić Klindžić 2010: 197). Both sites discussed in this paper are from the Linear A phase of the Starčevo Culture[1], while at Galovo there is also a more recent layer that corresponds to the Barice-Gređani cultural group. The absolute date of the site at Zadubravlje puts the settlement in the period between approximately 6000[2] and 5000 cal BC (Krajcar Bronić 2011: 183). At Galovo there are visible three Starčevo Culture settlement phases, with absolute dates between 6100 to 5000 cal BC (Krajcar Bronić 2011: 182). The Starčevo Culture settlements at Galovo and Zadubravlje were founded at a small geographic distance from one another and are mutually almost contemporaneous, which points to the interaction and coexistence of their inhabitants.

Structures were found at both sites related to production and daily life, including pit houses (both dwellings and those used for work activities), and structures on posts of unknown purpose. We do not see grave pits at the Dužine site in Zadubravlje, but we do see pits of small dimensions and specific inventories, such as the three-lobed Pit 22. The sites present an abundance of knapped lithic material in almost all phases of production. Functional analysis of knapped lithics was performed to compare activities performed in Starčevo Culture settlements that coexisted in the same area over a period of about 1 000 years[3].

Lithic analysis of finds from the grave pit SU 15/16 (Šošić 2007: 176-188), the working pit SU 291/292 (Bunčić 2009: 291-308) and the grave pit SJ 9/10 (Šošić Klindžić 2010) has been from Slavonski Brod – Galovo has been conducted. SU 14, 17, 19, 20, 23, 25, 27, 30 and 31 have as well been analysed but it is not certain if these finds can be related to the Starčevo Culture (Šošić Klindžić 2010: 148-151). The lithic analysis of the finds from Dužine in Zadubravlje was performed in 2009. and it included typological analysis, the analysis of raw materials as well as spatial analysis (Karavanić et al. 2009).

No traceological analysis[4] was performed on the lithic assemblage on these sites. This preliminary analysis of use-wear traces on lithic artefacts from Slavonski Brod opens the gate to further exploration of lithic industries as well as other everyday activities performed there.

Sickle gloss analysis of artefacts from these sites provides insight into the appearance of sickles and agricultural activity. Sickle gloss was confirmed on 19 artefacts recovered from Galovo and on two artefacts recovered from Zadubravlje in different contexts within the settlements.

The finds recovered from the Starčevo Culture strata in the settlements at Zadubravlje and Galovo (Minichreiter 2007) exhibit features of all aspects of the Neolithic package (see Childe 1958, but also Zvelebil 2002; Çilingiroğlu

[1] After Dimitrijević.

[2] Where the earliest date of 6600 cal BC was not considered (Krajcar Bronić 2011).

[3] The analysis was performed for unfinished PhD thesis *Rekonstrukcija svakodnevnih djelatnosti u naseljima starčevačke kulture analizom tragova uporabe lomljenoga kamenoga oruđa*.

[4] Excluding the commentary on 9 blades from SU 15/16 (Šoršić Klindžić 2010) and 2 blades from SU 291/292 (Bunčić 2009) that was given based on macroscopic observation.

2005; McCarter 2007; Shennan 2018; Nowak 2022), the biggest issue, however, is proving the presence of organised agriculture. In archaeological terms demonstrating the presence of early agriculture is relatively difficult. A small number of fossilized seeds were found at Zadubravlje[5] (Đukić 2014: 158), while no plant remains were found at Galovo. Neolithic cereals were found in Starčevo Culture contexts at the Sopot and Tomašanci-Palača sites (Reed 2014; 2015; 2020.). The sickle, i.e., sickle gloss on knapped stone tools, constitutes indirect evidence. Sickle gloss develops as the result of cutting plants like those from the *Gramineae* (domesticated cereals and other grasses, e.g., barley), *Typhaceae* (e.g., bulrush) and *Compositae* (e.g., marsh-elder) families (Vaughan 1985: 35-37). The objective of this paper is to establish the presence of sickle gloss on knapped stone artefacts at the Zadubravlje and Galovo sites. Although sickle gloss has at times been posited as present on finds recovered from other Neolithic period sites in Croatia on the basis of macroscopic examination (e.g., Forenbaher 2008; Šošić Klindžić 2010), functional analysis of use-wear traces on knapped lithic tools is scarce. Some of the exceptions are the use-wear analysis of the Dalmatian site Crno Vrilo (Kačar and Philibert 2022), and the analysis of artefacts with sickle gloss found on Dalmatian sites (Forenbaher 2008; Mazzucco et al. 2018), as well as analysis of the Palaeolithic period material recovered from the Mujina pećina (cave) site (Petru 2020). Continued work on functional analysis and the interpretation of use-wear traces is an essential source of new insight into knapped lithics from what Croatia is now.

Materials and Methods

This article includes the lithic assembly from the Galovo site excavated between 1997 and 2015. A total of 17606 finds were examined. Not all of the finds can be associated with certainty to Starčevo Culture, but all were examined for traces of wear. The lithic assembly of 17117 chert fragments originates from the Starčevo cultural horizons. A relatively small count of 19 artefacts used to cut cereals can be due to the presence of all the phases of chaîne opératoire that were present on site.

[5] The seeds were not further analysed.

In the assemblage of 5274 chert finds from Zadubravlje (Minichreiter 1992a: 35) use-wear from cutting cereals was observed on only two artefacts. It is essential to note that 80,33% of the finds can be characterised as "workshop assemblage" (Karavanić et al. 2009).

Nineteen blades, blade fragments, and tools on a blade from Galovo[6], and a truncated bladelet[7] ad a flake[8] from Zadubravlje, were isolated in the course of the functional analysis of the knapped lithic material as exhibiting sickle gloss[9] in its various phases of formation (Tab. 1).

All the finds exhibiting sickle gloss on the site of Galovo are blades and blade fragments. The entirety of the assemblage of finds exhibiting sickle gloss from this site consists of blades and tools created on blades; not retouched blades appear in eight cases (42.1%), there are two not retouched fragments of blades (10.5%), and seven truncated blades (36.8%), while one retouched blade and one trapeze each account for 5.3% of the total number of finds exhibiting sickle gloss. The observed damage is manifested as sickle gloss, edge rounding, and comet-shaped striations, visible both dorsally and ventrally, with an emphasis on the flat dorsal side. Functional analysis implies macroscopic and microscopic analysis of a tool's surface and is aimed at determining its purpose. It includes macroscopic examination with

[6] The artefacts are relatively small with an average length of 3.02 cm, width of 1.26 cm, thickness of 0.83 cm, and weight of 1.76 g.

[7] 1.98 cm long, 1 cm wide, 0.33 cm tick and 0.7 g in weight

[8] 2.82 cm long, 1.5 cm wide, 0.45 cm tick and 2.1 g in weight

[9] Sickle gloss is a characteristic wear trace present on tools used to cut silica-rich plants of the *Gramineae* (domesticated cereals and other grasses), *Typhaceae* (e.g., bulrush) and *Compositae* (e.g., marsh-elder) families. To the naked eye, it is recognisable as a high "wet" sheen that extends from the working edge and runs across much of a tool's surface. Sickle gloss is formed over an extended period, developing from small gloss-covered areas to coating the entire working edge, at times even the whole tool. Viewed microscopically, sickle gloss - in its most developed form - exhibits comet-shaped striations, pronounced rounding of the edge, and a dense, uniform, bright and "wet" surface sheen.
The formation of sickle gloss can be observed with a microscope. Sickle gloss is developed when silica compounds from the processed material meet the surface of the tool and, with the evaporation of water, adhere to it (Anderson 1980: 183-185). The speed at which the gloss develops is very slow and depends on the number of silica compounds and water in the plants being processed. Thus, grasses such as barley will develop lustre the fastest, and fresh plants will develop lustre faster than dry ones (Anderson 1980: 183; Vaughan 1985: 35). The gloss formed by the cutting of plants is very bright, shining from the surface of a tool and extending deep into its surface (Semenov 1964; Vaughan 1985: 36). Striations and comet-shaped pits often appear. These consist of a pit and a striation extending out from it and occur due to the non-uniformity of a tool's surface (Semenov 1964; Vaughan 1985: 36).

SF	Description	SU	Location of use-wear traces	Activity / sickle gloss phase	Worked material
G97 1293	Blade, grainy yellow chert	?	Right lateral edge towards the distal edge	Cutting / sickle gloss Ph.3	silicious plant - cereal
G99 391-10	Truncated blade, brown chert	3	Left lateral edge towards the distal edge	Cutting / sickle gloss Ph.4	silicious plant - cereal
G99 414-18	Fragment of a truncated blade, brown chert	3	Left lateral edge towards the proximal edge	Cutting / sickle gloss Ph.2	silicious plant - cereal
G01 663-5	Blade, light brown/ reddish chert	108	Left lateral edge distally and distal edge	Cutting / sickle gloss Ph.5	silicious plant - cereal
G02 1254-22	Blade, translucent white chert	154	Right lateral edge distally and distal edge	Cutting / sickle gloss Ph.2	silicious plant - cereal
G02 1302-25	Blade, grey/brown chert	156	Left lateral edge distally and distal edge	Cutting / sickle gloss Ph.5	silicious plant - cereal
G02 1305-12	Fragment of a blade, white chert	156	Right lateral edge distally and distal edge	Cutting / sickle gloss Ph.3	silicious plant - cereal
G02 1411-25	Truncated blade, light brown/reddish chert	206	Left lateral edge distally and distal edge	Cutting / sickle gloss Ph.5	silicious plant - cereal
G03 1713-39	Truncated blade, light yellow chert	154	Left lateral edge and distal edge	Cutting / sickle gloss Ph.4	silicious plant - cereal
G07 441-6	Blade, white chert with burn traces	980	Left lateral edge and distal edge	Cutting / sickle gloss Ph.4	silicious plant - cereal
G08 479-3	Blade, light brown/ reddish chert	4	Left lateral, proximal, and distal edges	Cutting / sickle gloss Ph.5	silicious plant - cereal
G08 483-4	Blade, light brown/ reddish chert	4	Right lateral edge and distal edge	Cutting / sickle gloss Ph.2	silicious plant - cereal
G09 556-3	Fragment of a blade, brown chert	3	Right lateral edge and distal edge	Cutting / sickle gloss Ph.5	silicious plant - cereal
G09 564-32	Blade, brown chert	3	Left lateral edge and distal edge	Cutting / sickle gloss Ph.5	silicious plant - cereal
G10 578	Blade, white chert	4	Left lateral edge and distal edge	Cutting / sickle gloss Ph.3	silicious plant - cereal

SF	Description	SU	Location of use-wear traces	Activity / sickle gloss phase	Worked material
G10 610	Truncated blade, yellow chert	2013	Left lateral edge and distal edge	Cutting / sickle gloss Ph.3	silicious plant - cereal
G11 703	Fragment of a blade with alternating retouch and truncation, dark brown chert	2243	Left lateral edge and proximal edge	Cutting/ sickle gloss Ph.4	silicious plant - cereal
G11 721	Truncated blade, brown chert	2243	Distal edge	Cutting / sickle gloss Ph.2	silicious plant - cereal
G12 763	Trapeze, white chert	2621	Right lateral edge and proximal edge	Cutting / sickle gloss Ph.3	silicious plant - cereal
ZA DU 179a	Truncated bladelet, light brown/reddish chert	Pit 8J	Left lateral edge distally and distal edge to the left	Cutting / sickle gloss Ph.3	silicious plant - cereal
ZA DU 333	Flake, light brown/ reddish chert	Pit 22	Left and right lateral edges and distal edge	Cutting / sickle gloss Ph.5	silicious plant - cereal

Table 1. Finds exhibiting sickle gloss from the Galovo site in Slavonski Brod and Dužine site in Zadubravlje

the naked eye and low-magnification loupes, microscopic examination, with a metallurgical microscope, usually at magnifications of from 100× to 400× and using SEM at various factors of magnification.[10] The work described here involved the use of an AmScope ME300TZB-2L-9M 40× to 2000× metallurgical trinocular microscope with 10× magnification at the objective and 20× at the eyepiece. Photographs were taken with an Olympus E-500 camera with a trinocular microscope photo eyepiece mount without additional magnification, as well as, in three cases,[11] with the original 9MP digital camera and were processed with the CombineZP software package to achieve depth of field. SEM imaging was performed at the INA laboratories[12] at 1200× magnification.

The archaeological material was compared against four experimental fragments of brown Slavonian chert, which correspond to the raw material of a part of the analysed finds. The experimental fragments were inserted into a wooden handle and were used to cut wild grasses and cereals in the spring, and ripe wheat in the summer. The more pronounced results were produced by the cutting of ripe wheat. Two experimental specimens were inserted, without adhesive, into a curved piece of wood. After two and a half hours of use an intensive sickle gloss formed at the working edge, while fine chipping appeared at the opposite edge. The process of the formation of the gloss was monitored under a microscope and was consistent with the phases of formation as described on the archaeological material later on. The specimen was imaged with a metallurgical microscope at 200× magnification, and under an SEM at 1200× magnification (Fig. 1).

The experimentally obtained gloss corresponds to the gloss identified on archaeological material and the published reference collections (Keeley 1980; Vaughan 1985; Van Gjin 2010; Bogosavljević Petrović 2016; Bogosavljević Petrović et al. 2017). Vaughan (1985: 36) described three phases in the formation of sickle gloss: generic weak polish, smooth pitted polish, and well-developed polish. In

[10] SEM provided high quality photographs in larger magnifications (up to 2400x)
[11] Fig. 4b, Fig. 7b and Fig. 15b
[12] Imaged by Mario Matošević

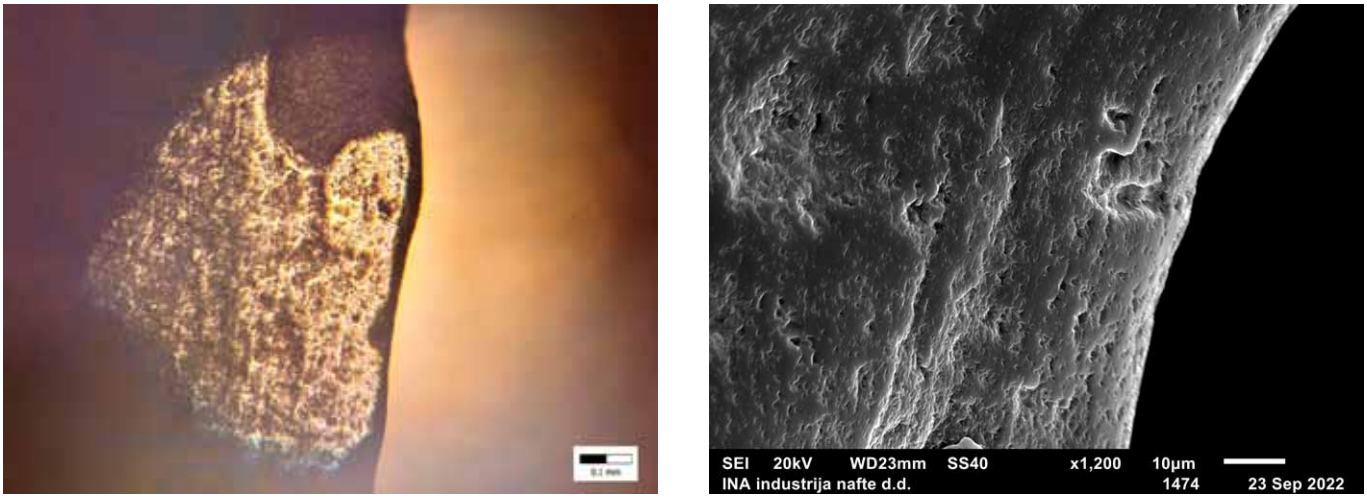


Figure 1. Sickle gloss on tools from the reference collection at 200× magnification under a metallurgical microscope(a) and at 1200× under an SEM (b).

the production of this paper, there were five discernible phases in the formation of sickle gloss visible at 200× magnification. Differences, namely, in the appearance of damage that corresponds to Vaughan's second phase were shown to be very prominent, prompting a finer discrimination. The first phase of sickle gloss corresponds to Vaughan's generic weak polish and cannot be differentiated from glosses formed in the initial phases of use on other materials. Consequently, this paper does not cover finds exhibiting damage from the first phase of sickle gloss formation. In the second phase the gloss develops at the highest points on the tool surface, there is no linkage between the highly glossy elevated spots, and the lower parts show more topography while being soft and rounded. In the experiment the second phase of use-wear traces developed after about 45 minutes of working. In the third phase high spots merge, forming a network. The characteristics of traces stayed the same as in phase two, but elevated spots developed further "covering" the lower parts of the tool surface. It developed after about 1 hour and a half of cutting cereals. The fourth phase in the development of sickle gloss is characterised by pitting that appears in the developed gloss. The surface is mostly elevated, smooth and pitted with smaller areas of lower softly rounded, with more pronounced topography. It developed in the next 45 minutes of work. These three phases correspond with Vaughan's smooth pitted polish. They can be recognised as the early phases of the formation of sickle gloss. The fifth phase is a well-developed, dense, transparent gloss that covers the working edge and deep into the surface of the tool. It corresponds to Vaughan's final phase. It developed in the final stages of the experiment. In this phase, grooves along the rounded edge started appearing. These grooves are due to the same motion of cutting individual strains of cereals (Bogosavljević Petrović et al. 2017: 38). Along with the gloss, from the second phase on we also see the appearance of comet-shaped striations, where the "tail" indicates the orientation of use. We also see pronounced edge rounding. There is fine chipping present on some specimens, less frequent on the working edge and more frequent on the edge opposite to it. Gloss on experimental flakes largely corresponds with phase four gloss, although we do see phase five gloss appearing closer to the working edge.

Cutting of wild grasses and cereals in spring was performed with a similar "small sickle" consisting of two inserts inserted in a curved wooden handle without adhesive. After three hours of cutting wild grass a small amount of traces, mostly visible as underdeveloped sickle gloss, were achieved.

Archaeological finds were first cleaned with a soft plastic brush and water. When necessary, recent polish or glue applied due to inventory was removed with acetone. Prior to microscopic examination alcohol was used to remove any residue due to recent handling. Experimental tools were cleaned with a soft plastic brush and soapy water, alcohol, and acetone to remove any residue.

Results

Sickle gloss on finds from Slavonski Brod – Galovo and Dužine near Zadubravlje was divided into 5 stages of formation depicting the degree of tool use. The first phase corresponds to generic weak polish, the second, third, and fourth phases correspond to smooth pitted polish, while the fifth phase corresponds to well-developed polish. The phases of polish formation were observed on experimental tools as well as archaeological finds. Only the tools that show phases two, three, four, and five were considered since the generic weak polish is not exclusively characteristic of certain traces of wear. All the finds exhibit a highly reflective, glossy surface in different ratios. Protruding parts show high gloss with comet-shaped striations. Sunken parts are more topographic while still quite rounded. The amount of linkage is described through phases: phase two demonstrates the least amount of linkage, glossy spots are contained in small areas with a lot of sunken space, phase five shows no sunken space, the texture of the surface is smooth, almost reflective, comet-shaped striations are clearly visible. The rounding of the working edge is noticeable in all the described tools. In two cases[13] residue on the surface of the find was spotted, but further analysis is necessary to confirm its origin.

Damage caused by cutting silica-rich plants that runs along the left lateral and distal edges of blades was observed on truncated blade G99 391-10 (Fig. 2) of brown chert from layer SU 03, blade G01 663-5[14] (Fig. 3) of light brown/reddish chert from work activity pit house SU 107/108, blade G02 1302-25[15] (Fig. 4) of grey/brown chert from work activity pit house SU 155/156, truncated blade G02 1411-25 (Fig. 5) light brown/reddish chert from work activity pit house SU 205/206, truncated blade G03 1713-39 (Fig. 6) light yellow chert from work activity pit house SU 153/154, a blade of white chert with burn traces G07 441-6[16] (Fig. 7) from the uninvestigated pit house SU 979/980, a blade of brown chert G09 564-32 likely from grave pit SU 2012/2013[17] (Fig. 8), and a blade of white chert G10 578 (Fig. 9) from layer SU 04, and G10 610 (Fig. 10) yellow chart from grave pit SU 2012/2013.

On the distal fragment of a truncated blade of brown chert G99 414-18 (Fig. 11) from layer SU 03 the characteristic damage runs from the left lateral edge to the broken proximal edge.

Sickle gloss running from the right lateral edge to the distal edge was observed on blade G97 1293[18] (Fig. 12) of grainy yellow chert, blade G02 1254-22 (Fig. 13) of translucent white chert from pit house dwelling SU 153/154, a fragment of a blade without a bulb of white chert G02 1305-12 (Fig.14) from work activity pit house SU 155/156, G08 483-4[19] (Fig. 15) of light brown/reddish chert from layer SU 04, and the medial fragment of a blade of brown chert G09 556-3 (Fig. 16) which likely comes from grave pit SU 2012/2013.[20]

A blade with alternating retouch and truncation G11 703 (Fig. 17) of dark brown chert from grave pit SU 2242/2243 exhibits sickle gloss on the left lateral and proximal part, while a trapeze of white chert G12 763 (Fig. 18) from north excavation SU 2620/2621 of semicircular fence SU 2194/2195 exhibits sickle gloss on the right lateral edge, from which it runs to the tool's proximal edge.

Sickle gloss on a blade of light brown/reddish chert G08 479-3 (Fig. 19) from layer SU 04 is present on the left lateral, distal, and proximal edges, while on a truncated blade of brown chert G11 721 (Fig. 20) we see it only on the distal edge.

Blades and tools on a blade from the Galovo site in Slavonski Brod exhibit a preferential distribution of sickle gloss over one lateral to a distal or, less often, a proximal edge, with gloss covering the blade surface diagonally in a triangular form.

Fine chipping is not a common phenomenon on tools exhibiting sickle gloss, although it does sporadically appear in the form of a retouch or damage to the working edge

[13] On G08 483 – 4 and G03 1713 – 39.
[14] The sickle gloss on the find was imaged using an electron microscope at 1 200× magnification.
[15] G02 1302-25 exhibits a certain degree of PDSM, but it does not cover the entirety of the observed surface and the original phase two of use-wear is still recognizable.
[16] The topography of use-wear on silica-rich plants is still visible, and the gloss is observed only in the triangular shape consistent with other traces of use on the working edge, the rest of the tool is smoothened and crackled due to exposure to fire.
[17] Given the positions of finds within layer SU 03, which Botić (oral communication) posits also contains the tops of Starčevo Culture pits/bottoms of Barice-Gređani cultural group pits.
[18] Unknown find position within the Galovo site in Slavonski Brod, 1997.
[19] Some PDSM striations are visible, but the topography of the tool surface shows traces of use-wear, there is a significant amount of rounding and formation of polished surfaces in contrast to the pitted surfaces.
[20] Given the positions of finds within layer SU 03, which Botić (oral communication) posits also contains the tops of Starčevo Culture pits/bottoms of Barice-Gređani cultural group pits.

as seen on finds G97 1293, G01 663-5, G02 1254-22, G10 610, G12 763 and on G02 1411-25 and G08 483-4, on which we also see fine chipping of the lateral edge opposite the working edge. Damage on the lateral edge is visible on finds G99 414-18, G02 1302-25, G02 1305-12 and G09 564-32. Possible traces of resin, i.e., an adhesive, were observed on the medial part of blade G08 483-4.

Of the 19 blades and fragments of blades exhibiting sickle gloss from Galovo, seven are from the group of truncated blades (G99 391-10, G99 414-18, G02 1411-25, G03 1713-39, G10 610, G11 721) of which one has an alternating retouch on the right lateral edge (G11 703), and one trapeze has been observed (G12 763). Truncations and trapezes exhibit abrupt retouch, which is typical of these types of tools.

Blades exhibiting sickle gloss come from various contexts within the sites, whereas for those from layers SU 03 and 04 the cultural affiliation has not been confidently attributed. A part of the finds recorded in these layers may be attributable to the bottoms of pits of the Barice-Gređani cultural group, or the tops of pits of the Starčevo Culture (Botić oral communication). None of the fragments exhibiting traces of wear can relate to another in the same group, i.e., to the same sickle. The tools found were not always used to the point of full gloss development. The first phase has not been considered here. From the second phase, there are truncated blades G99 414-18 and G11 721 and blades G02 1254-22 and G08 483-4. Blades G97 1293, G02 1305-12, and G10 578, truncated blade G10 610, and trapeze G12 763 exhibit phase three wear. We see fourth phase wear on truncated blades G99 391-10, G03 1713-39, G11 703, and blade G07 441-6. Fifth phase wear is found on blades G01 663-5, G02 1302-25, G08 479-3 and G09 564-32, blade fragment G09 556-3, and truncated blade G02 1411-25.

At the Dužine site in Zadubravlje sickle gloss was observed on two finds, which exhibit third and phase five sickle gloss. Truncated bladelet PNL 179A (1989) (Fig. 21) from Pit 8 of light brown/reddish chert exhibits phase three gloss. The gloss is manifested on the left lateral edge distally, and on the distal edge to the left, with fine chipping present on the working edge and the lateral edge opposite the working edge. On flake PNL 333 (1990) (Fig. 22) of light brown/reddish chert from Pit 22 fifth phase sickle gloss is present on the left and right lateral and distal edges, with retouch present on the right edge. Comet-shaped striations and edge rounding are present on both specimens. No indicators of wedging into a composite tool were observed, apart from fine chipping on the right lateral edge of PNL 179A (1989).

In all second and fourth phases, sickle gloss formation is present on four finds (19.05%). Five finds from Galovo and one from Zadubravlje exhibit phase three sickle gloss formation, accounting for 28.57% of the total number of finds exhibiting sickle gloss. The fifth phase is most represented, with a total of seven finds, one of which is from Zadubravlje, i.e., 33.33% in all.

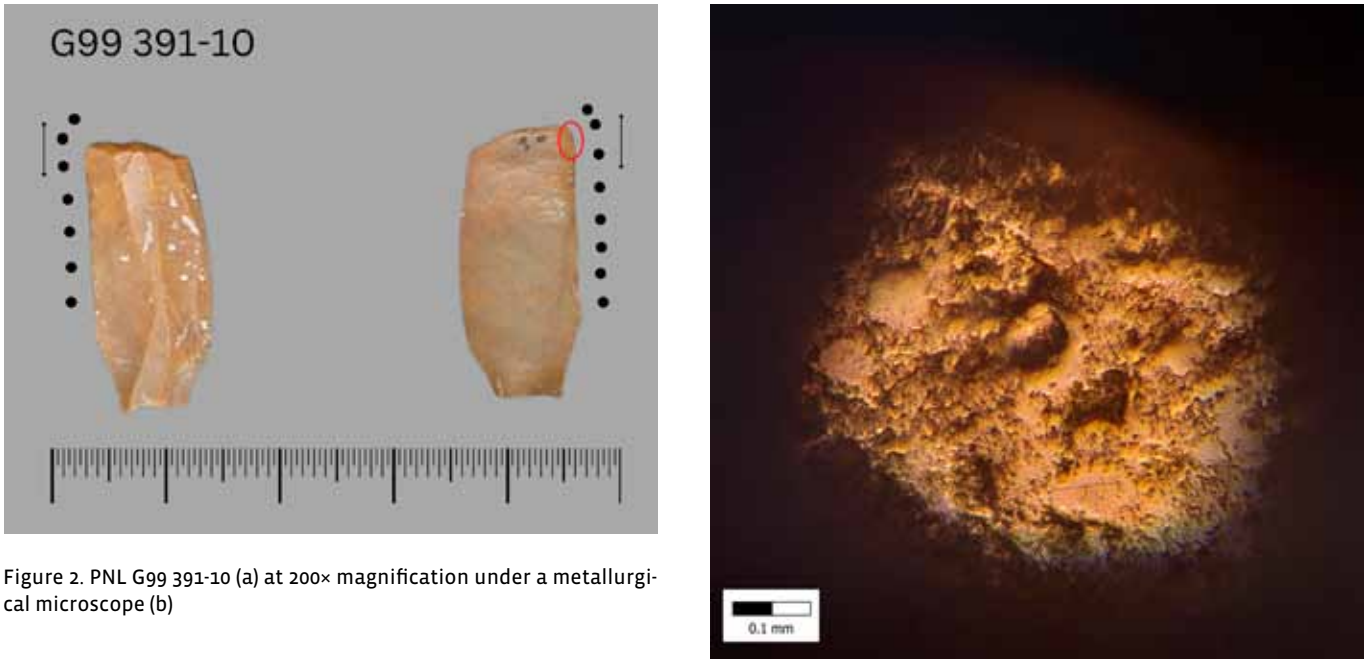
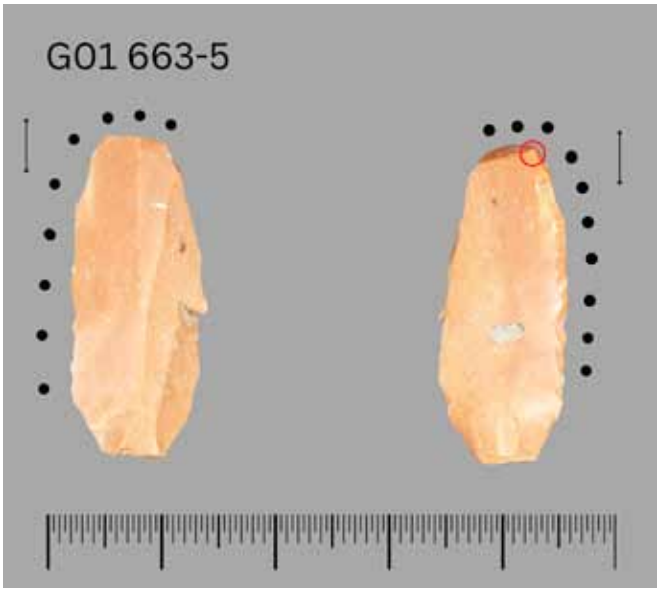
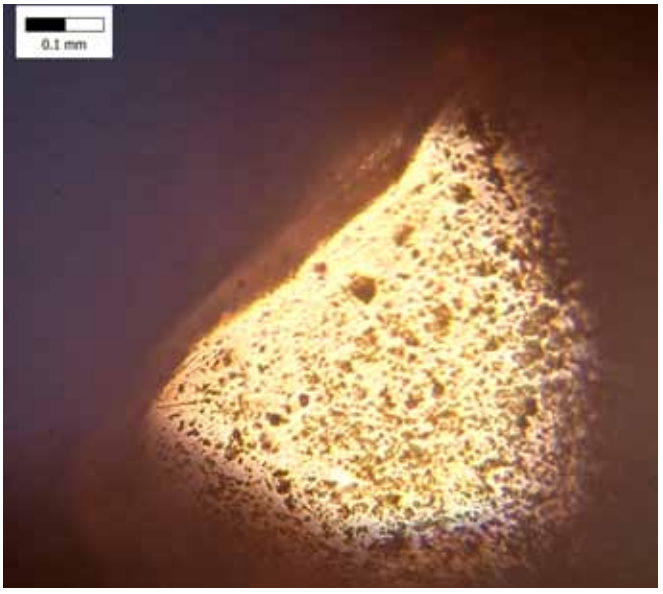


Figure 2. PNL G99 391-10 (a) at 200× magnification under a metallurgical microscope (b)





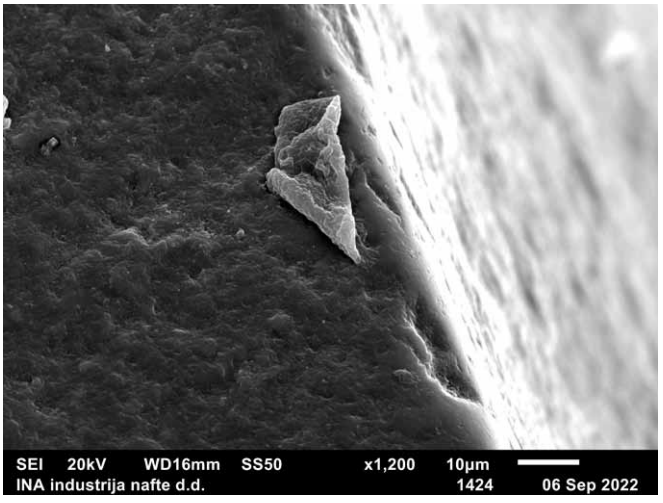
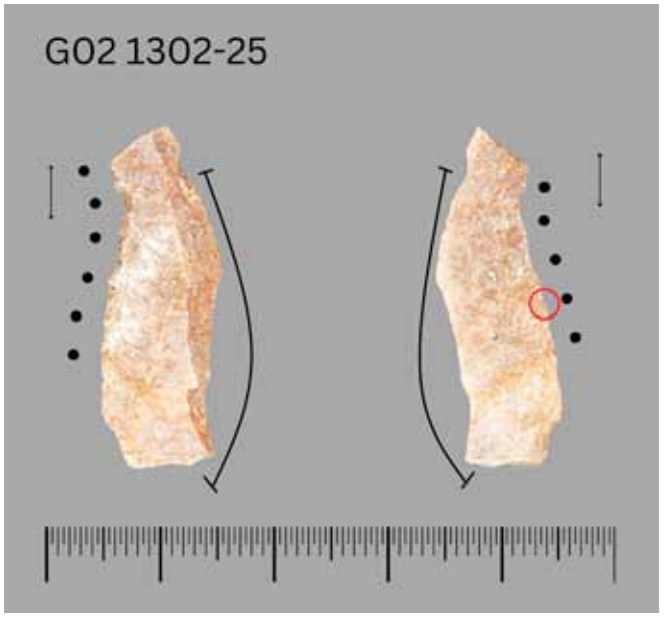


Figure 3. PNL G01 663-5 (a) at 200× magnification under a metallurgical microscope (b) and at 1200× under an SEM (c)



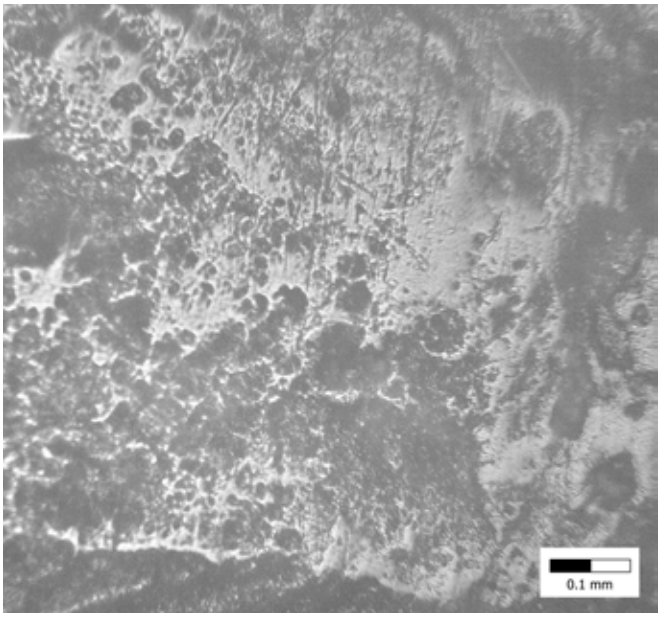


Figure 4. PNL G02 1302-25 (a) at 200× magnification under a metallurgical microscope (b)

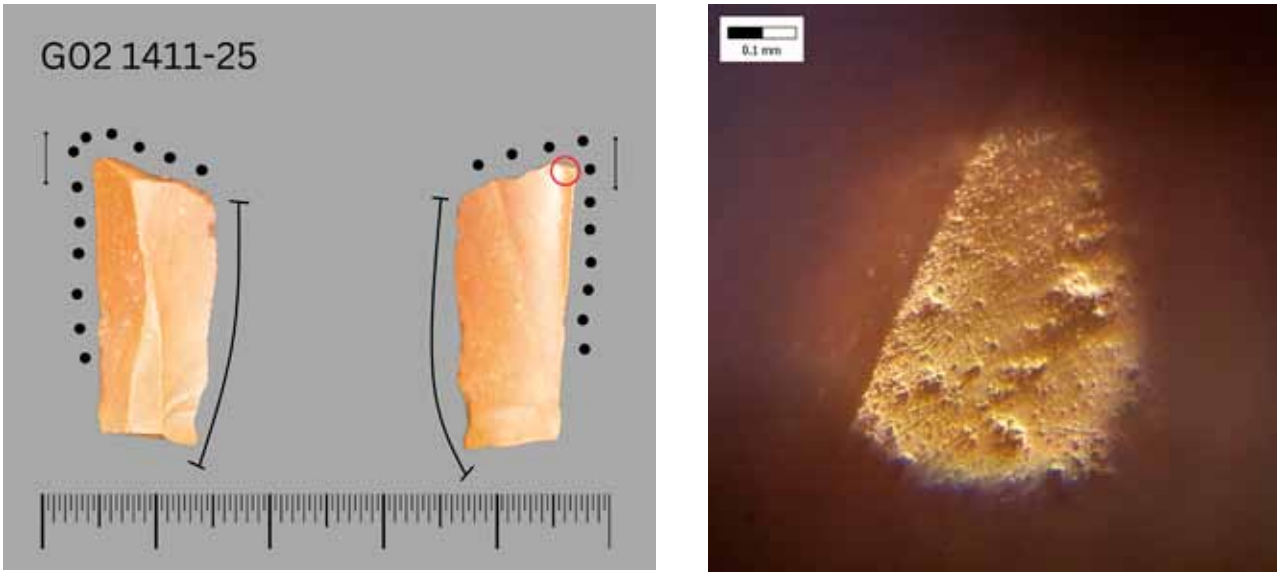


Figure 5. PNL G02 1411-25 (a) at 200× magnification under a metallurgical microscope (b)

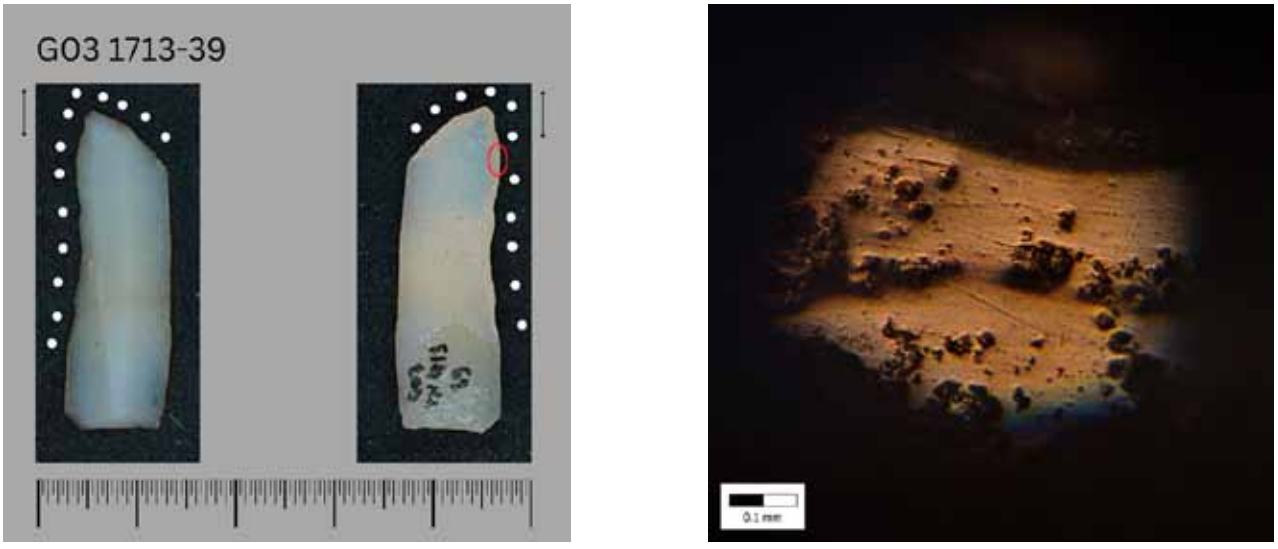


Figure 6. PNL G03 1713-39 (a) at 200× magnification under a metallurgical microscope (b)

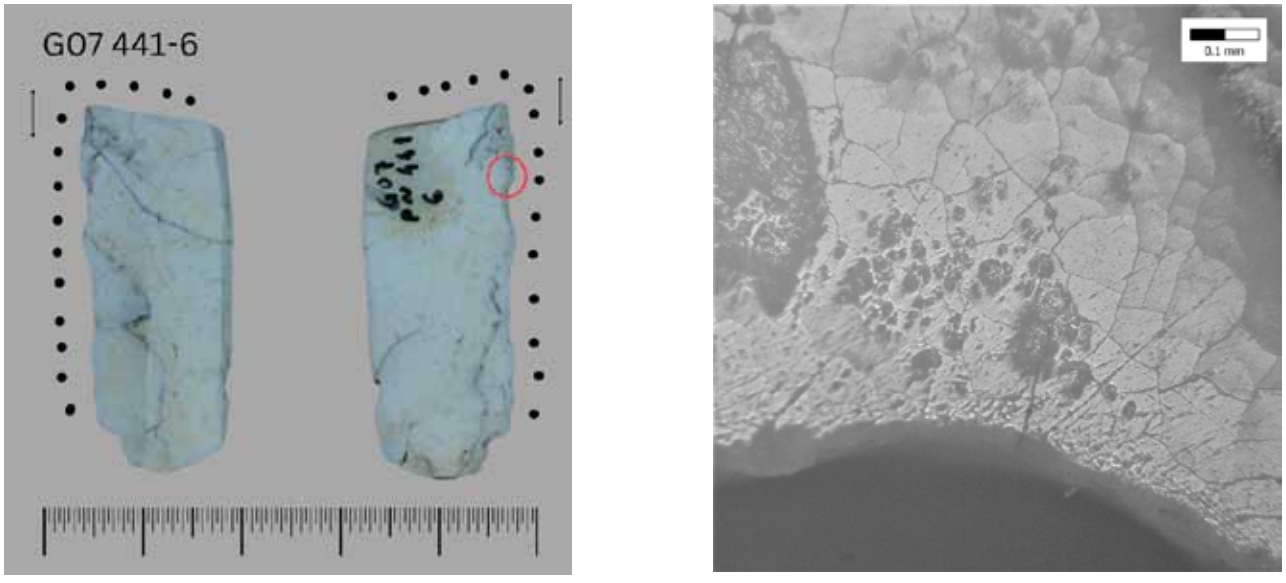


Figure 7. PNL G07 441-6 (a) at 200× magnification under a metallurgical microscope (b)

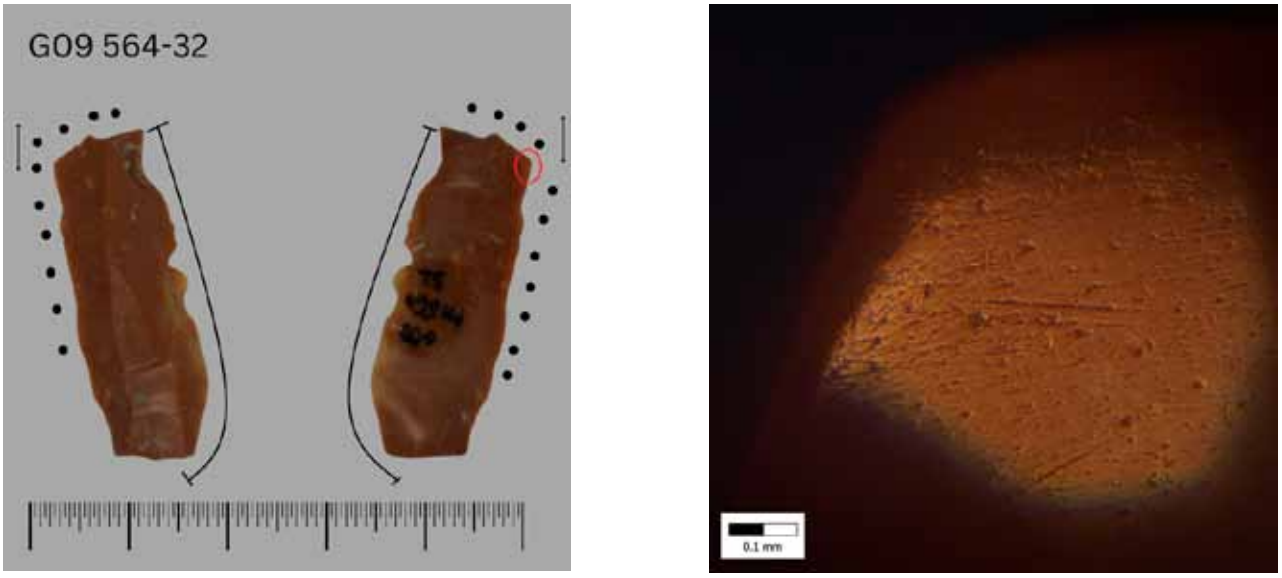


Figure 8. PNL G09 564-32 (a) at 200× magnification under a metallurgical microscope (b)

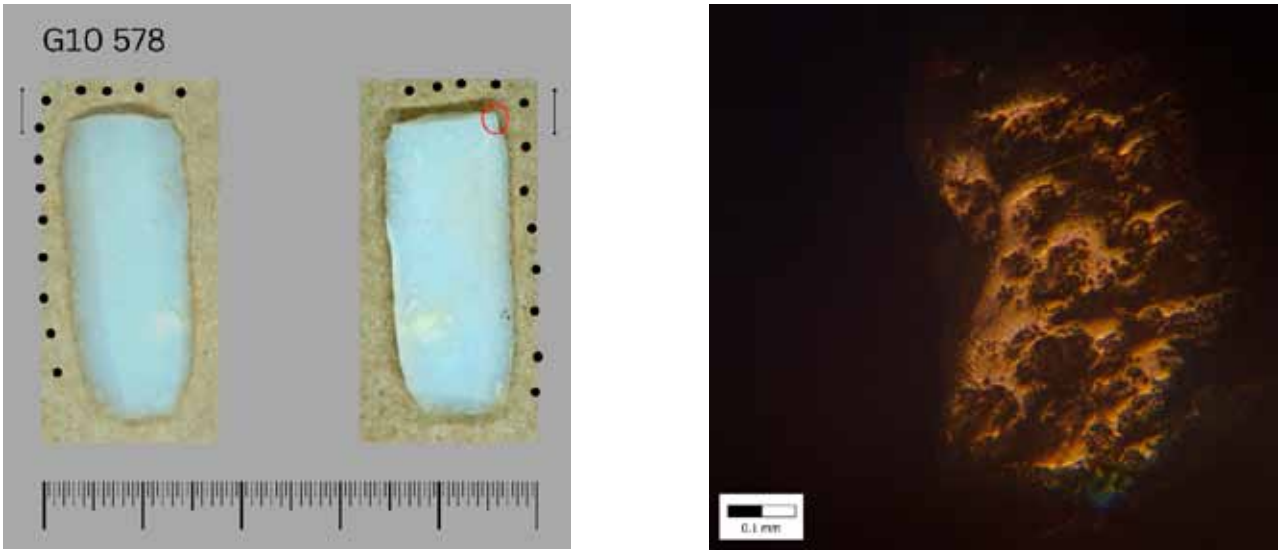


Figure 9. PNL G10 978 (a) at 200× magnification under a metallurgical microscope (b)

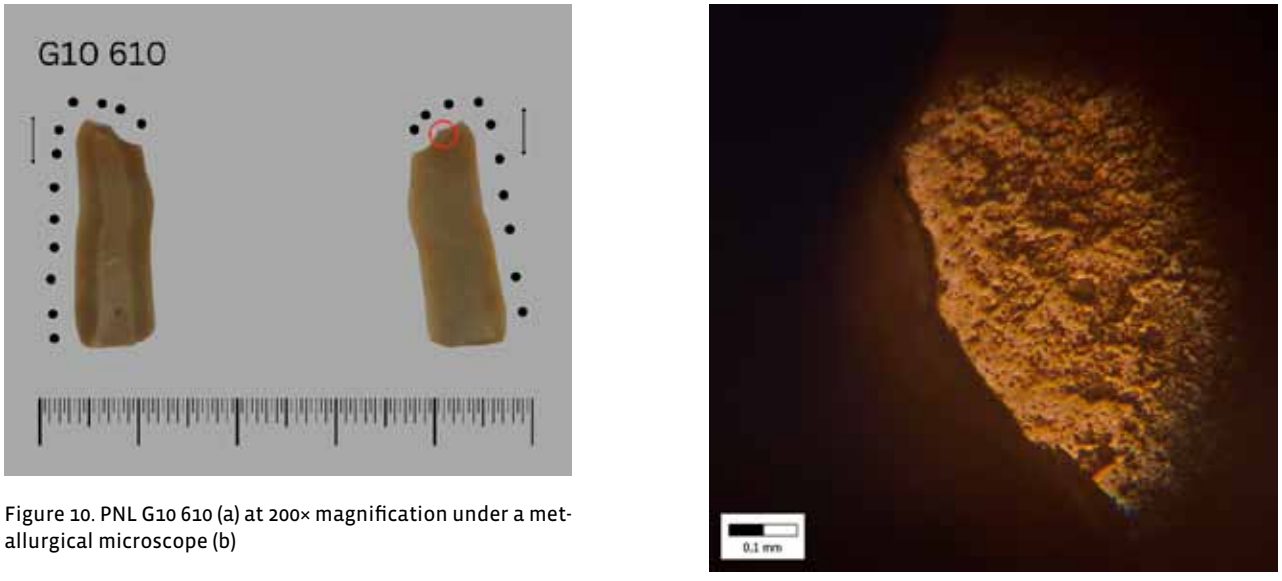


Figure 10. PNL G10 610 (a) at 200× magnification under a metallurgical microscope (b)

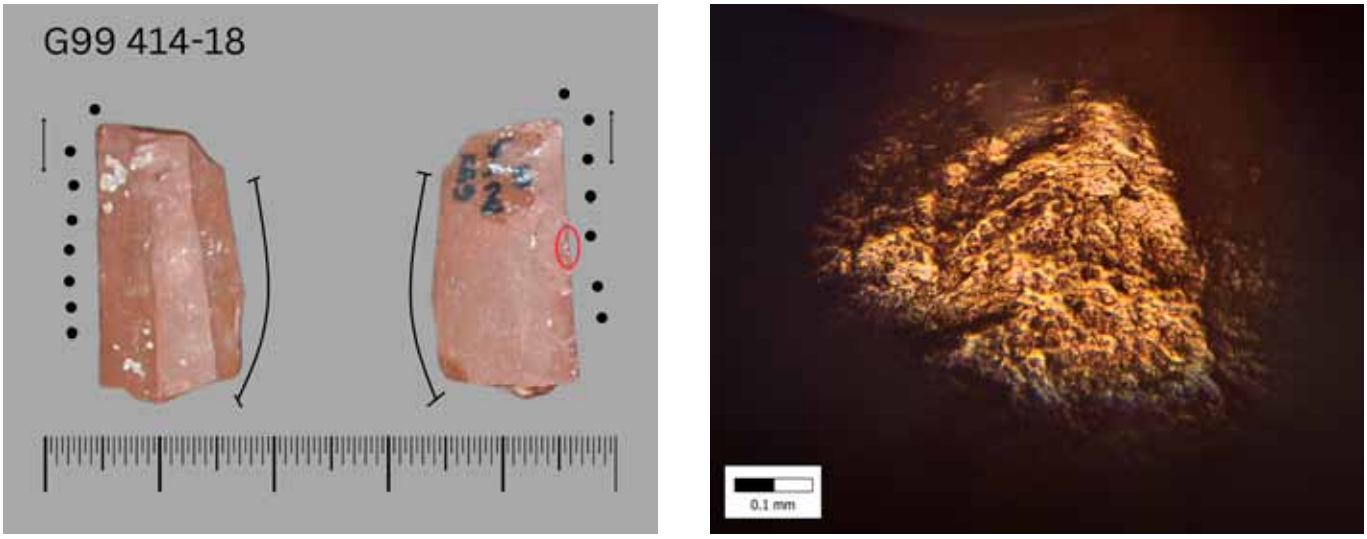


Figure 11. PNL G99 414-18 (a) at 200× magnification under a metallurgical microscope (b)

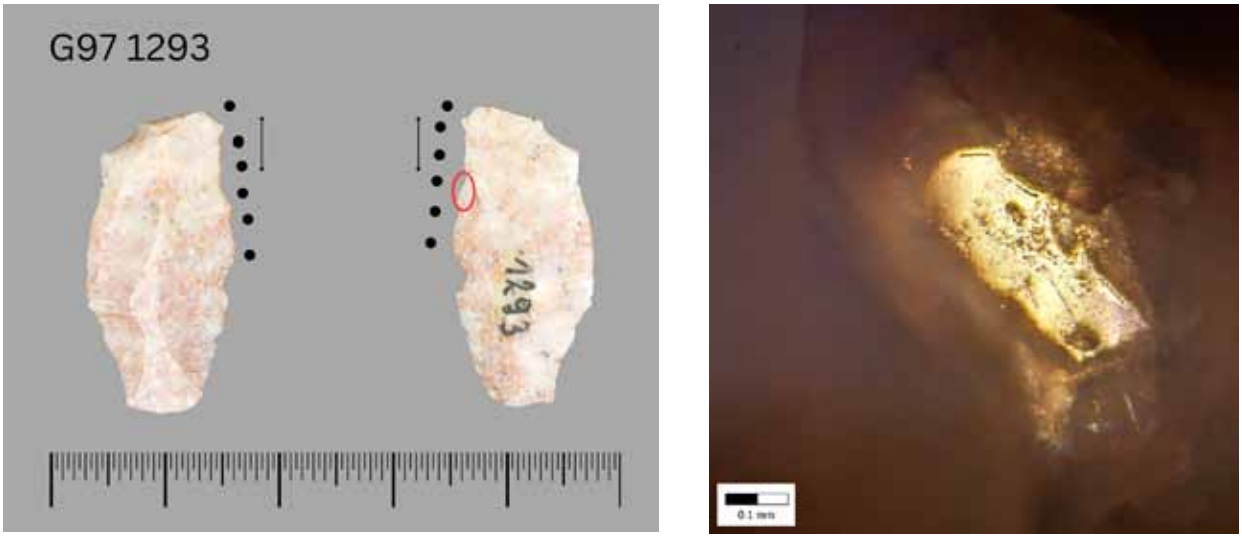


Figure 12. PNL G97 1293 (a) at 200× magnification under a metallurgical microscope (b)

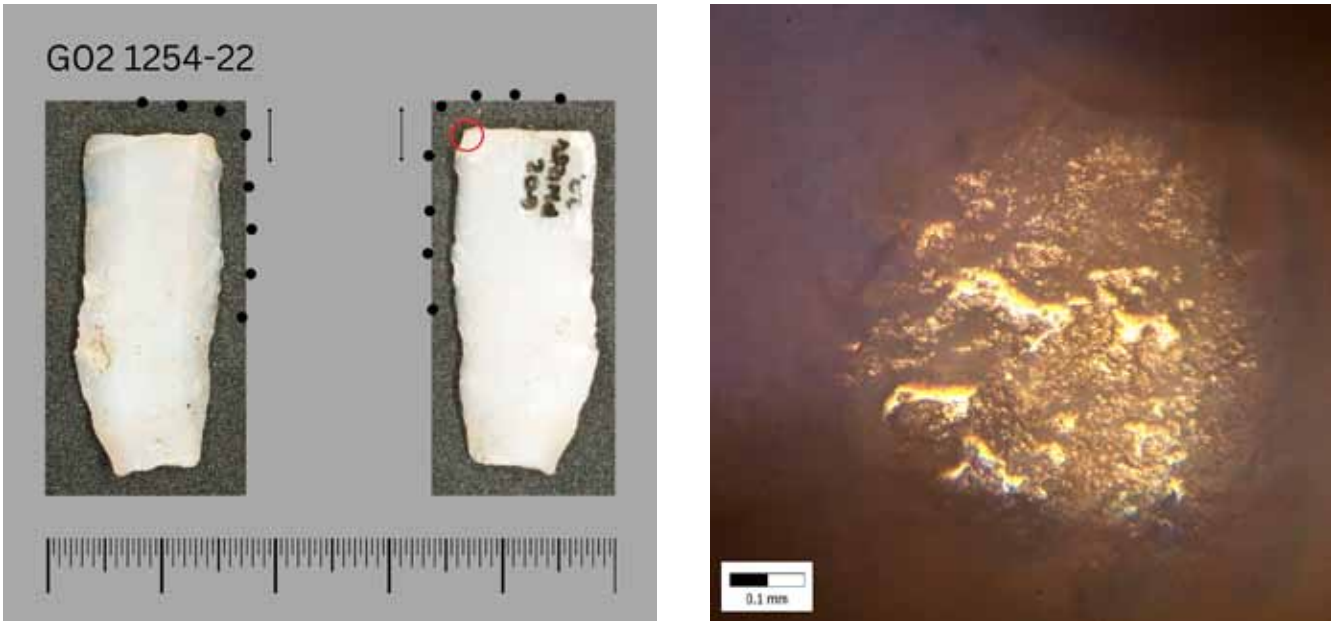


Figure 13. PNL G02 1254-22 (a) at 200× magnification under a metallurgical microscope (b)

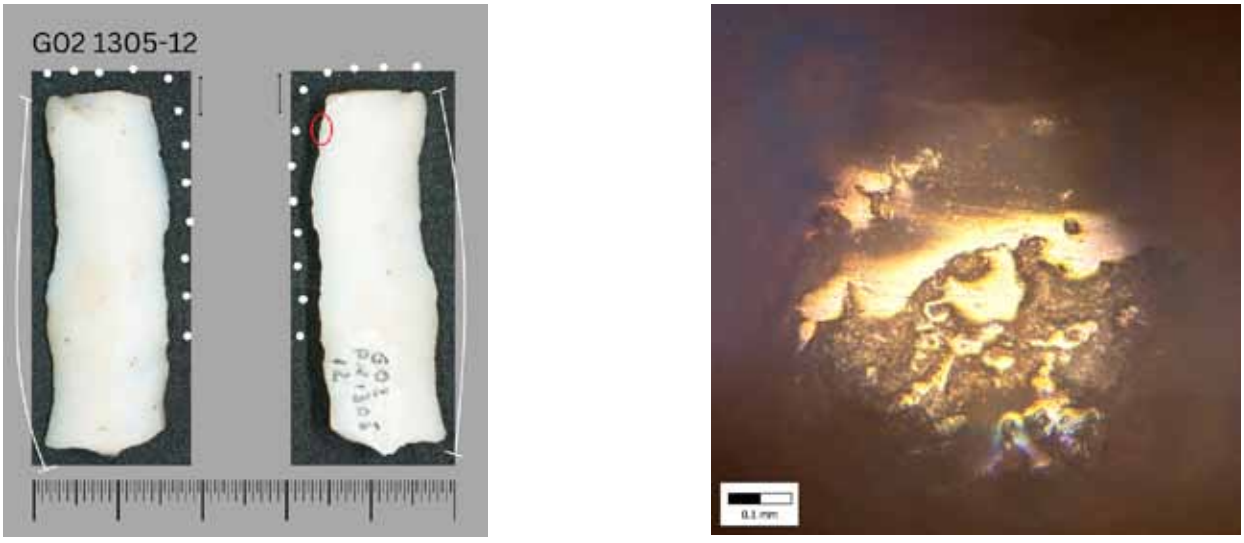


Figure 14. PNL G02 1305-12 (a) at 200× magnification under a metallurgical microscope (b)

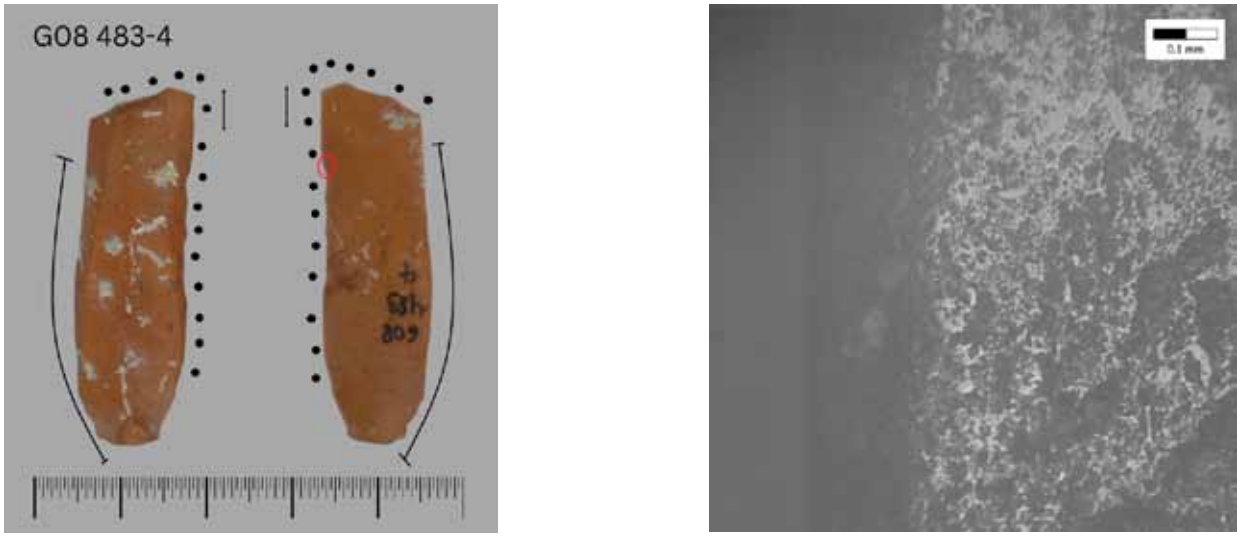


Figure 15. PNL G08 483-4 (a) at 200× magnification under a metallurgical microscope (b)

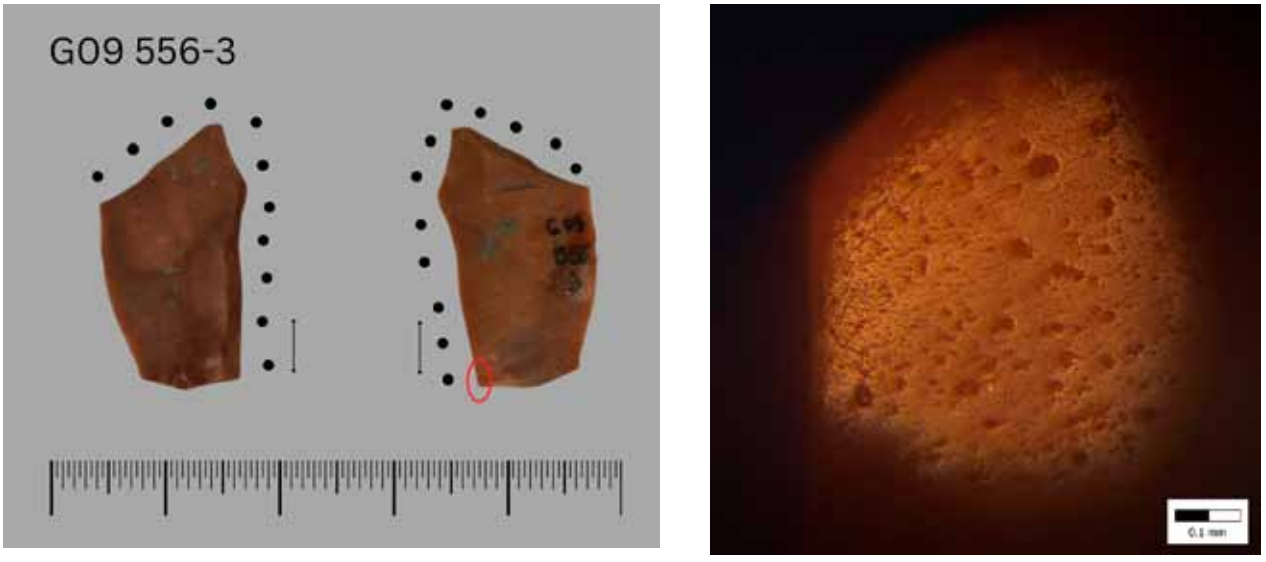


Figure 16. PNL G09 556-3 (a) at 200× magnification under a metallurgical microscope (b)

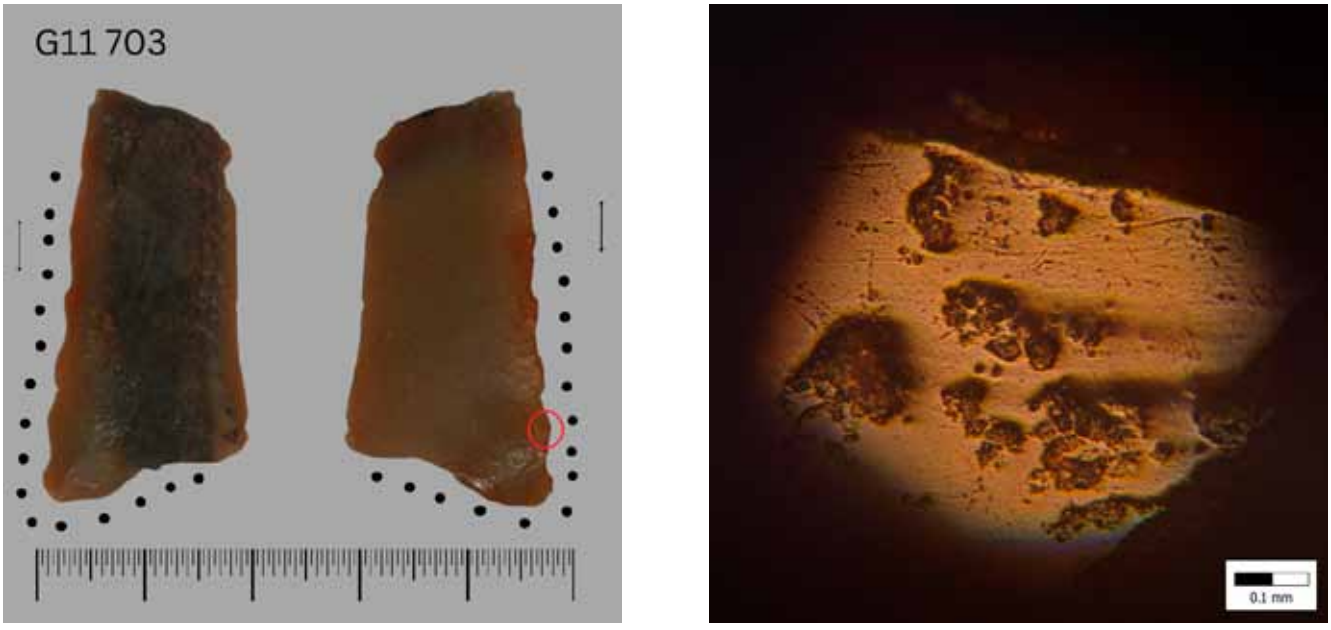


Figure 17. PNL G11 703 (a) at 200× magnification under a metallurgical microscope (b)

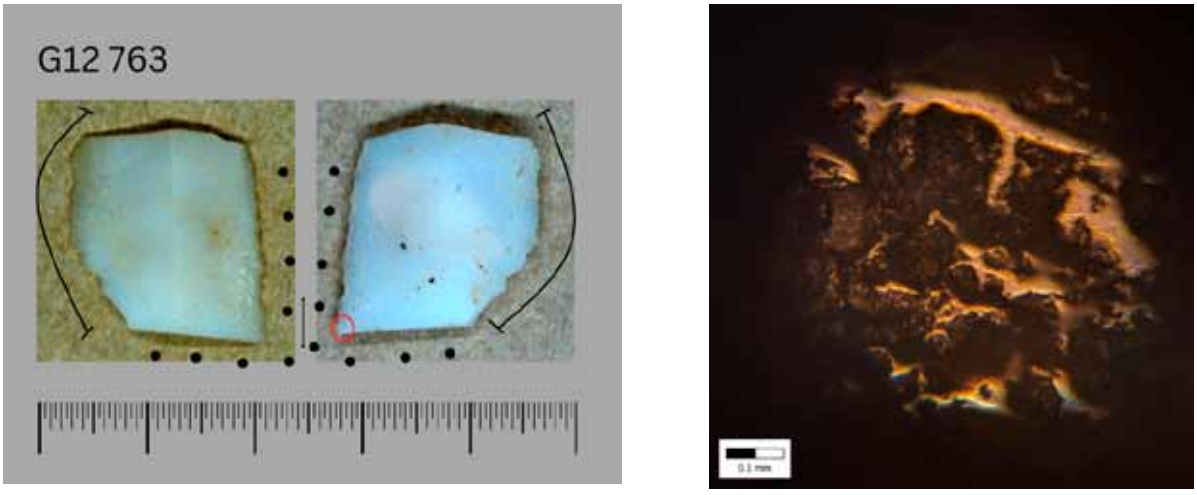


Figure 18. PNL G12 763 (a) at 200× magnification under a metallurgical microscope (b)

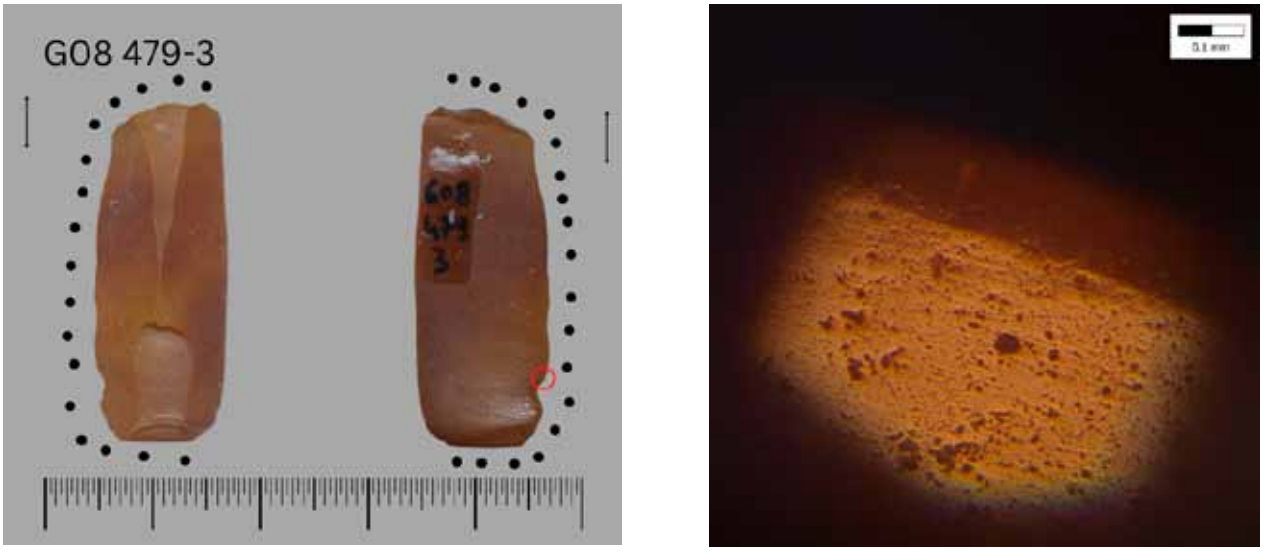


Figure 19. PNL G08 479-3 (a) at 200× magnification under a metallurgical microscope (b)

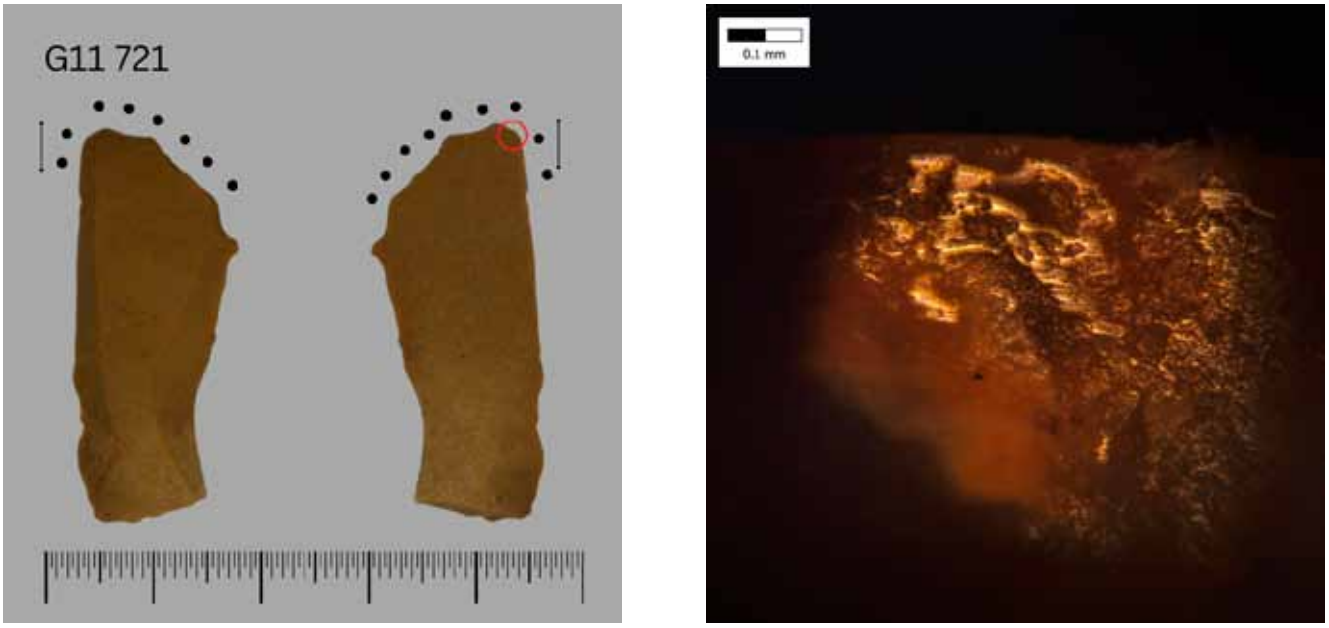


Figure 20. PNL G11 721 (a) at 200× magnification under a metallurgical microscope (b)

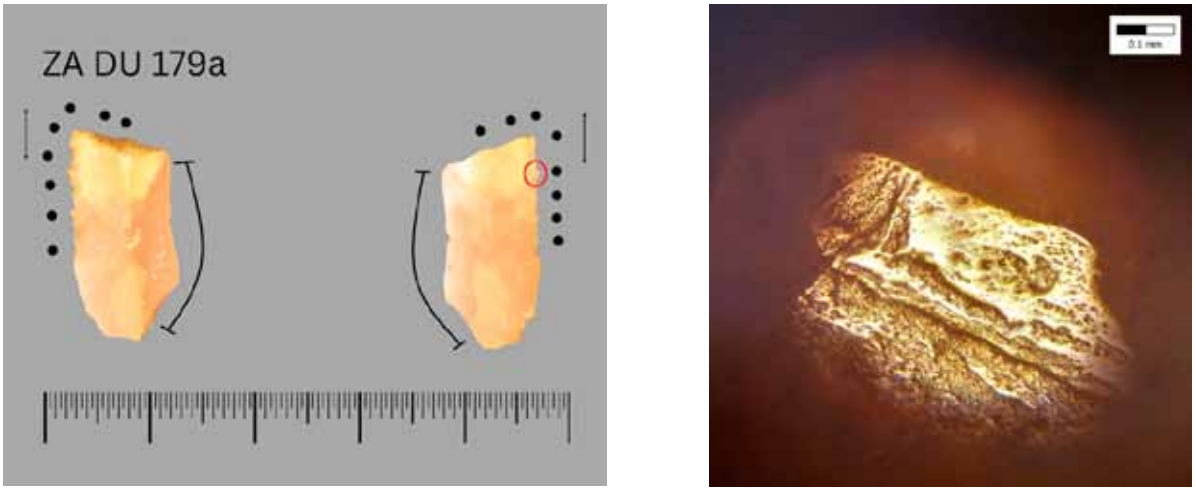


Figure 21. PNL ZA DU 179A at (a) 200× magnification under a metallurgical microscope and (b) at 1200× under an SEM

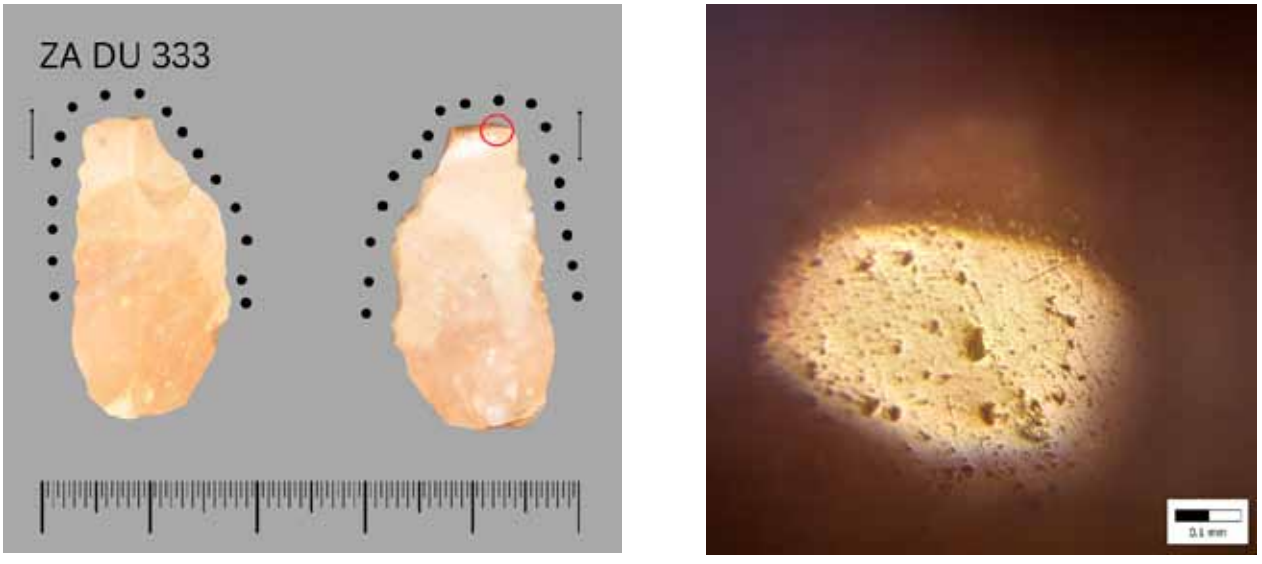


Figure 22. PNL ZA DU 333 at (a) 200× magnification under a metallurgical microscope and (b) at 1200× under an SEM

Discussion

The Starčevo Culture settlements at Galovo and Zadubravlje coincide chronologically across almost their entire duration. The attribution of these settlements to the early Starčevo Culture, based on the components of the Neolithic package, presumes the production of cereal crops. Organic remains, however, are not easily proven *in an archaeological context*, and the lack of use-wear evidence of harvesting cereals does not immediately imply the lack of agricultural effort (Petrović et al. 2021: 29). Fossilised cereal grains have been found in the archaeological strata, as is the case at Zadubravlje,[21] but the methodology of the excavation of Neolithic settlements (Reed 2014: 158) often provides an incomplete picture. Domesticated cereals came to what is now Croatia from the Middle East around 6000 cal BC (Reed 2014: 157), which coincides with the formation of settlements at Galovo and Zadubravlje. The first cultivated species were einkorn wheat (*Triticum monococcum*), emmer wheat (*Triticum dicoccum*), barley (*Hordeum vulgare*), peas (*Pisum sativum*), lentils (*Lens culinaris*), chickpeas (*Cicer arietinum*), bitter vetch (*Vicia ervilia*) and flax (*Linum usitatissimum*) (Zohary 1996). Over 70 samples of plant remains were collected at the Tomašanci-Palača Starčevo Culture settlement site (Reed 2020), constituting the first direct evidence of agriculture in the region. Remains of einkorn and emmer wheat, barley, lentils, flax and dwarf elder (*Sambucus ebulus*) were found (Reed 2014: 158; 2020: 252). Finds of bread wheat (*Triticum aestivum*) and spelt (*Triticum spelta*) were made in the Starčevo Culture strata at the Sopot site (Reed 2015: 606).

Tools for the cultivation and processing of plants are secondary indicators of the exploitation of cereals. Sickle gloss is one of the most relevant indirect indicators of agriculture, along with chemical analyses (Torrence and Barton 2006) such as lipid analysis (Charters et al. 1993; Evershed et al. 1995; Hammann et al. 2022) and dental plaque (Christiani et al. 2016; Jovanović et al. 2021). Although sickle gloss is often visible to the naked eye, the functional analysis must be performed microscopically. The small number of samples of domesticated plants may be the result of the investigative methodology (Reed 2014: 158), but also of the limited import or theft of domesticated plants from nearby agricultural settlements. Food processing tools such as grindstones and knapped lithics found both at Galovo and Zadubravlje (Minichreiter 1992a; 1992b; 2007) point to the intensive use of domesticated plants. The species has not been determined in the case of the find of cereals at Zadubravlje, while at Galovo there were no similar finds. At the same time, only two finds exhibiting sickle gloss originate from Zadubravlje. The greater number of finds exhibiting sickle gloss from Galovo is an indicator of agricultural production at this site.

When analysing the distribution of finds at Galovo one ought to bear in mind that for a part of the finds from layers SU 03 and SU 04, no confident determination of cultural affiliation has been made, as described above. Seven of the finds from these strata should be considered with reservation, even though they do correspond to blades and fragments of truncated blades on which sickle gloss extends diagonally, as has also been observed on finds from Starčevo Culture structures. One find is from an unknown context. The remaining 11 finds originate from structures. Four of the finds are from work activity pit houses SU 107/108 (1), SU 155/156 (2) and SU 205/206 (1), three are from grave pit contexts SU 2012/2013 (1) and SU 2242/2243 (2), two from pit house dwelling SU 153/154, one from uninvestigated pit SU 979/980, and one from SU 2620/2621, which is the north excavation of semi-circular fence 2194/2195. The bulk of finds exhibiting sickle gloss at Galovo are from the contexts of work activity pit houses and grave pits. Work activity pit houses correspond to a broad range of activities, evident among which are food preparation, pottery manufacture, and lithic technology. This distribution of finds indicates that the sickle was a relatively specialised tool that had its place in the workshop environment. Associating a sickle to a particular individual is likely not feasible, although blades have also been found in grave contexts. Given that the burial ritual in the Starčevo Culture is typical of Croatian Neolithic, where the deceased is interred in an oval grave pit in a crouched position with little or no personal accessories (Težak-Gregl 1998: 65-68), these blades probably did not constitute the deliberate inventory of a grave.[22] Further investigation is needed because the sample is too small, and we lack a complete set of blades from a single sickle.

Pits 8 and 22 at Zadubravlje are smaller in size (Minichreiter 1992b). Pit 22 has a specific shape, and an unusual inventory (including the find of a turtle shell) and layout.

[21] The species of the remains could not be determined (Minichreiter 1992a, 31, 51)

[22] In a wider area, Early Neolithic graves occasionally show a larger number of grave goods (e.g. Vlasac) (Borić et al. 2014).

Minichreiter describes it as a cult pit (Minichreiter 2005: 9). Notably, the inventory of this pit includes the sole flake, of elongated form, confirmed as exhibiting sickle gloss at these two sites.

Blades, retouched and unretouched are, next to flakes, predominant at Starčevo Culture sites in the broader area of distribution (Šošić Klindžić 2010; Šarić 2014: 160-161), as evidenced by the finds from Galovo and Zadubravlje. The 19 finds from Galovo constitute a group comprising blades, blade fragments of which six are truncations, and one is a trapeze. These finds exhibit sickle gloss in various phases of development. Vaughan (1985) describes three phases in the development of gloss, of which two can be attributed to use on silica-rich plants, and where the first phase should be considered separately because the generic weak polish is generally characteristic of initial use-wear trace development. The analysis of finds from Galovo required discriminating between five phases of gloss development indicating the degree of tool use. The first phase again corresponds to generic weak polish. The second, third, and fourth phases correspond to smooth pitted polish, while the fifth phase corresponds to Vaughan's well-developed polish (1985). The necessity of introducing a broader division was prompted by the significant differences observed in the development of the degree of damage on individual finds, which was also evident in experimental tools. The presence of finds exhibiting different phases of sickle gloss development indicates that not all the tools were used to the final stage of wear prior to being discarded, deliberately or unintentionally. This can be compared to the observation that Mazzucco et al. (2018.) noticed on sickle blades from nine sites in Dalmatia dated between 6000 - 5300 cal BC (Forenbaher et al. 2013). Sickle blades attributed to the Early Neolithic Impressed Ware phase were mostly replaced rather than reshaped, such was the practice in the later Danilo layers (Mazzucco et al. 2018: 94-95). We see the same division among the finds from Galovo.

Thirteen of the finds from Galovo exhibit a clearly visible distribution of the gloss on one lateral and one transversal edge. At times the gloss extends to the other transversal edge. On two additional finds from Galovo, the gloss is distributed on one lateral edge and a part of one transversal edge. The distribution of sickle gloss and attendant use-wear traces, especially in combination with fine chipping at the edge opposite to the working edge may indicate – based on comparisons with the experimental material – the wedging of blades into a composite tool. The diagonal distribution of gloss we see on fifteen

Figure 23. Conceptual reconstruction of the kind of sickle that may have been used in the Starčevo Culture settlement at the Galovo site in Slavonski Brod.

of the Galovo finds and one find from Zadubravlje identify the angle at which the blades were inserted into the handle. When used, the edges of the debitage inserted into a wooden handle opposite the working edges are pressed against the surface of the handle, which produces fine chipping. Chemical analysis of what may be traces of resin, i.e., an adhesive, observed on one specimen from Galovo may further corroborate the appearance of a composite tool as thus envisaged. Given the lack of flakes and tools on a flake exhibiting sickle gloss among the finds from the Galovo site in Slavonski Brod we can posit that composite sickles at this site were crafted by the diagonal insertion of blades, truncated blades and, less often, trapezes into a handle of organic material, which has not survived.[23] Use-wear traces observed on the finds from Galovo and Zadubravlje show sickle gloss distributed diagonally across the segments, indicative of a more or less curved composite sickle with diagonally set teeth, which is consistent with Group 1 composite sickles of the Riedschachen type according to Pétrequin et al. (2006) (Fig. 23). Sickles of the same shape have been identified at sites in Bulgaria, for example, the Tell Karanovo site (Gurova and Bonsall 2014), that is attributed to the Čavdar-Kremikovci-Karanovo Culture group of the Starčevo cultural complex (Težak-Gregl 1998: 63) and the Impressed Ware Culture in Dalmatia (Mazzucco et

[23] The handle at Galovo and Zadubravlje were most probably wooden and not made of antler as Bogosavljević Petrović (2016; 2017) suggested in experiments connected to agriculture of Late Neolithic of Srbija.

al. 2018), as well as in the Early Neolithic of Greece, Albania, Monte Negro, Italy (Mazzucco et al. 2020), Spain, and south France (Ibáñez-Estévez et al. 2008: 185-186). The two finds exhibiting sickle gloss from Zadubravlje only partially correspond with the sickle type observed at Galovo. The bladelet from Zadubravlje exhibits the diagonal distribution of sickle gloss. There are not enough finds from Zadubravlje for any confident determination of the appearance of sickles at this site. Group 1 composite sickles were likely used, with the sickle cutting diagonally at the middle of the stalk, to harvest densely planted fields (Pétrequin et al. 2006). Sickle gloss on finds from Galovo indirectly point to the presence of agricultural activity, and we can thus confidently posit that this site presents all of the features of the Neolithic package. Further investigation is required to confirm the entirety of the Neolithic package at Zadubravlje. At Galovo we see the entire Neolithic package, which is to be expected given the chronological position of the Starčevo Culture in the broader sense.

Conclusion

Nineteen finds from Galovo and two from Zadubravlje exhibit sickle gloss. At Galovo most are blades, fragments of blades with or without truncation, and - as an exception - one trapeze, while at Zadubravlje the finds are a bladelet, which does not correspond with most of the Galovo finds only in terms of their size, and a flake from Pit 22. On sixteen of the finds, sickle gloss is distributed diagonally along the body of the tool, occupying for the most part one lateral edge and one transversal edge. Less often the gloss runs to a part of the other lateral edge. In some cases, the lateral edge opposite the working edge exhibits fine chipping, and on one specimen a residue was observed that may be a resin that secured the tool in a handle. The distribution of wear points to the conclusion that sickles at the Galovo site were composite sickles of the Group 1 Riedschachen type as described by Pétrequin et al. (2006: 109-112), in which blades or truncated blades and, less often, trapezes were inserted. The same distribution of wear was noticed by Mazzucco et al. (2018) on examples from the Early Neolithic Impressed Ware Culture in Dalmatia. A handle of organic material, most likely wood, diagonally intersected a chert microlith. No set was found that could be characterised as a single sickle, which, in combination with the different degrees of gloss development, may point to the replacement of sickle segments that had worn out or had been lost. Finally, the lack of a complete set means that we do not know the form of sickle handles from Galovo and Zadubravlje, although blades exhibiting gloss on three edges may indicate that the sickles were of the more or less curved type (Pétrequin et al. 2006), as this achieves the functional alignment of the edges. This sickle configuration would correspond with Neolithic sickles found in Bulgaria, Greece, Albania, Monte Negro, Dalmatia, Italy, France and Spain (Ibáñez-Estévez et al. 2008: 185-186; Gurova & Bonsall 2014; Mazzucco et al. 2018; 2020). The appearance of the sickles of individual Cultures may point to the process of Neolithisation and the introduction of agriculture into an area (Ibáñez-Estévez et al. 2008: 183-196). If these processes are also to be followed in eastern Europe we will require further investigation of use-wear traces and the development of a typology of Neolithic sickles in this area.

Given the number of finds and the various contexts in which they were found, and their morphology, we can confidently posit that the inhabitants of the Galovo site, and likely of the site at Zadubravlje, used the described composite sickles to cut silica-rich plants, which is also indicated by the find of cereals at Zadubravlje. Given that the Starčevo Culture in all other segments corresponds to Childe's Neolithic package, that it marks the first Neolithic phenomenon in the Brodsko Posavlje region (Težak-Gregl 1998), and that it chronologically corresponds to the Middle Neolithic in the broader sense, that the sickle gloss on tools from these sites is the result of the cutting of domesticated cereals.

In conclusion, it is necessary to continue with the functional analysis of the lithic assembly of the Starčevo-Körös-Criş cultural group as well as of its both temporal and spatial neighbouring cultures to procure data on everyday activities of their inhabitants. Results obtained in this study indicate similarities between the Early Neolithic sickle inserts from the Brodska Posavina region with Early Neolithic sickles from the entire northern Mediterranean region.

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