

Osseous tools and personal ornaments from the Epigravettian sequence at Badanj

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Research Article

Keywords: Upper Palaeolithic, personal ornaments, osseous tools, barbed points, beads, parietal engraving, Badanj

DOI: <https://doi.org/10.21203/rs.3.rs-209080/v1>

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Abstract

The Late Upper Palaeolithic (Epigravettian) sequence at Badanj has yielded an important dataset about the occupation of the hinterland of the Eastern Adriatic catchment zone in the late Pleniglacial. The site also harbors one of the rare occurrences of Upper Palaeolithic parietal “art” in southeastern Europe in the form of a large rock engraving. Another notable aspect of the site is the presence of engravings on portable objects made from bone. The first excavations at Badanj, conducted in 1976–1979 in the zone around the engraved rock, yielded a surprisingly large number of personal ornaments (over 1000 specimens) from a variety of primarily marine gastropods, scaphopods, and bivalves, and red deer canines. Here we review what is currently known about the site and report our preliminary findings from the study of the collection of personal ornaments as well as osseous tools, some of which were marked by regular incisions forming decorative motifs. We also report two new direct accelerator mass spectrometry (AMS) dates on antler barbed points.

Introduction

Studying the Late Upper Palaeolithic period along the rim of the Adriatic Basin offers one of the best opportunities to examine resilience and change among prehistoric foragers over time in their responses to some of the rapid shifts in climatic conditions towards the end of the Pleistocene. These climatic shifts and ensuing habitat losses significantly altered landscapes and directly affected mobility patterns of human groups and their geographical distribution. After several short interstadial events, between 28 and 21 thousand years ago (henceforth kya), the ice advance accelerated after 25 kya cal BP, leading to the Last Glacial Maximum (henceforth LGM) (22 ± 2000 kya BP).¹ These changes also caused the shrinking of the Adriatic Sea (up to 130 m below the current levels²), opening a large land bridge, known as the Great Adriatic Plain, between Italy and the Balkans in the northern parts of the Adriatic Basin (Fig. 1). While some authors have envisaged the Great Adriatic Plain of the LGM as a zone of high resource productivity³ others have maintained that this was an inhospitable, saline, and desolate land, characterized by swamps and strong winds.⁴ Be that as it may, many authors have considered the Balkans, along with other areas of southern Europe, as one of the European refugia for plant, animal, and human populations, with favorable environments during the LGM. Around 15.3 ky cal BP, there was a rapid amelioration of climatic conditions with the onset of the Bølling/Allerød interstadial oscillations, which led to the melting of glaciers in the Alpine region, prompting a re-colonization of higher altitude locations by human groups here and elsewhere. It also triggered a process of inundation of the Great Adriatic Plain with the rise of sea levels and isostatic rebound. Such changes, in all likelihood, considerably affected the territorial organization of Late Epigravettian groups.⁵

The sequence at the rock-shelter of Badanj in Herzegovina, located some 35-40 km from the LGM coast of the Adriatic Sea, documents the period of the Oldest Dryas from around 16 kya cal BP as well as the period of the site's occupation in the course of the Bølling/Allerød interstadial conditions, likely up to the very end of this phase and before the onset of the rapid cooling known as the Younger Dryas around

12.7 kya cal BP. Hence this site offers a focused glimpse of the conditions of life and cultural expression of foragers in this part of the Balkans during some of the key moments of the late Pleniglacial. While the state of research into this period along the Eastern Adriatic catchment zone is far from perfect, since the discovery of Badanj in 1976, there has been a growing number of field research projects and analytical work at other sites across the region.⁶ These studies have started to elucidate various aspects of what is referred to as the Epigravettian period—a culture-historical taxonomic label that is here used as an extension of the phenomenon previously defined at a number of sites on the other side of the Adriatic Basin, in Italy, due to similarities between the two zones.

In this paper, we will review what has been learned about the Badanj Epigravettian sequence to date, while at the same time offering new data from the first systematic study of osseous tools and personal ornaments from this site. These new data are briefly discussed in the context of other broadly contemporaneous sites along both sides of the Adriatic Basin and further to the south in Albania and Epirus, and broader issues to do with diachronic changes in forager settlement systems and seasonality.

Geographical Setting, Engraved Rock, and Research History

The locality of Badanj (N 43° 4' 52.77", E 17° 53' 7.94", ca. 100 masl) was recognized as an archaeological site in early June 1976, based on the reports about finds of ceramics and lithics. This rock-shelter is located near the village of Borojevići, 7 km to the west of the small town of Stolac, down the Bregava River. The site is located some 45 m above the valley bottom of the Bregava River, which here passes through a 18-km-long and 100-m-deep canyon, eventually ending as one of the tributaries of the larger Neretva River to the west.⁷ The site is around 30 km away from the nearest present-day coast of the Adriatic Sea as the crow flies albeit over a rugged karstic terrain (Fig. 2), with many areas characterized as “angry karst.”⁸ Hence it is more likely that the longer route along the Neretva River valley was used as the main corridor of communication with the coast during prehistory.

The shelter is naturally carved into one of the prominent and heavily eroded karstic escarpments, near its top (Fig. 3). The sheltered part of the site protected from the elements encompassed some 40 m². In more recent times, Badanj was used as a shelter for goats, based on the testimonies that around 1 m of goat dung was removed by the local villagers as fertilizer for near-by agricultural fields in the 1960s and early 1970s. A local high school teacher, Miroslav Palameta, was the first to report the existence of flint and ceramic finds found on the surface of the site to the archaeologists of the National Museum of Bosna and Herzegovina in Sarajevo. The rock engraving found on one of the large boulders at Badanj was spotted already at this time.⁹

The rock engraving was made on a boulder slanting at an angle of 30° from the west to the east (Fig. 4A). The boulder must have originated from the roof of the shelter. The engraved scene appears on the upper surface of the boulder, in its southwestern corner (Fig. 4B-C). It was damaged and contained a

possible depiction of the rear right side of a large quadruped interpreted by Basler as a horse with its right hind leg shown straight, the thigh and stifle shown in the foreground and also possibly the left hind leg (none of the hoofs shown) less deeply engraved and left floating as if depicting a movement of the animal. Basler¹⁰ maintains that before the upper levels with recent goat dung and the top archaeological layer were removed, the boulder was covered by archaeological levels from the later Epigravettian use of the shelter. He also suggested that people might have lit fire over the engrave boulder in antiquity. The leg and back parts of the outline were stressed by deeply carved lines (up to 5 mm) while the area inside the outline was further filled with multiple longitudinally engraved lines some of which also seem deeply carved. There is a possible representation of male sex as well as “arrowheads” that might have pierced the stomach of the depicted animal. Basler¹¹ speculated that the rock might have served as a place of initiation of young hunters.

The first archaeological excavations at the site were conducted by Đuro Basler, a curator at the National Museum of Bosnia and Herzegovina in Sarajevo, from 1976 to 1979, covering around 50 m² of the eastern part of the shelter. Apart from one article written in 1976 about the discovery of Badanj, with descriptions of the engraved boulder and its significance,¹² and a later, relatively short, summary of flint industry, osseous tools, and ornaments provided by Đuro Basler in his coverage of the Palaeolithic of Bosnia and Herzegovina in the synthetic volume *Praistorija jugoslavenskih zemalja I: paleolitsko i mezolitsko doba*,¹³ there is no detailed published information about the first investigations of this site. Furthermore, the National Museum of Bosnia and Herzegovina in Sarajevo does not possess detailed field records of the investigations made by Basler at Badanj, apart from the collection of inventoried material collected at the site and the inventory books with information about the provenance of inventoried finds. Despite the current uncertain state of field documentation from Badanj, accounts of those who participated at the excavations in 1976–1979 confirmed that the sediment excavated at the site was transported for dry or water sieving (Fig. 5),¹⁴ which might have contributed to the large number of recovered flint artifacts as well as beads (see below). Arbitrary cuttings were 10 cm thick based on depth measurements of each artifact provided in the museum inventory book.

In 1986–1987, the second phase of research at Badanj commenced in the framework of a collaborative international project entitled “Palaeolithic-Mesolithic Occupation of the Adriatic-Mediterranean Zone of Bosnia and Herzegovina,” led by Zilka Kujundžić of the National Museum of Bosnia and Herzegovina in Sarajevo and Robert Whallon of the Museum of Anthropology and Department of Anthropology at the University of Michigan, Ann Arbor, USA.¹⁵ The area investigated during the 1986–1987 excavations encompassed the western part of the site, exposing a surface of around 35 m² (Fig. 6). The investigated 10-m-long and 3-4-m-wide transect ran from the back wall of the shelter to the front edge of the site, beyond the dripline (the limit of the area of the site sheltered from elements by the overhanging roof) (Fig. 7). Excavated layers were primarily distinguished by following sediment and texture changes in the sediment matrix and rarely by arbitrary cuttings. The smallest spatial collection unit was one-quarter square meter (0.5 by 0.5 m) within a 1 by 1 m grid. All sediments were water-sieved using 3-mm wire

mesh-screens with a subsample containing several liters of excavated sediment selected for flotation and fine water-sieving with nylon stockings.¹⁶

Stratigraphy

There is not much information currently available on the stratigraphic sequence unearthed during Basler's excavations at the site in 1976–1979 apart from information that the depth reached in various parts of the trench he excavated around the engraved rock was from 1.5m to 2.3 m deep, measuring from the surface encountered in 1976.¹⁷ Relative depths of artifacts could be used as very coarse-grained indicators about early versus later parts of the stratigraphic sequence in making very broad comparisons with stratigraphic units and their characteristics more securely established during the second research phase (see below). The reached depth of up to ca. 2 m of archaeological deposits, judging by the provenance of artifacts found at this depth, suggests a deep stratigraphic sequence in this central part of the shelter.

In the course of the second research phase in 1986–1987, some 29 archaeological layers were recognized in a meter-deep trench, with the depth often varying from 80–90 cm only.¹⁸ The thickness of layers varied from only few centimeters to several thicker layers of 10–15 cm. A representative published stratigraphic section is provided here (Fig. 8) as well as the available description of the physical properties of each of the discovered units along with the available information about features and material culture recognized within each of the units (Table 1). There is a gentle dip of all layers towards the back wall of the shelter, from just outside the present-day dripline, probably following the slope of a natural depositional cone formed by eroded rubble, i.e., sterile *éboulis* from the shelter roof. There was a large hearth complex, found towards the back of the shelter, which both cuts through and interingers with various levels. There are at least four major divisions within this continuous hearth sequence. It has been suggested that there is a considerable degree of vertical mixing in the area of the hearth, and it has been excluded from the published analysis of lithics¹⁹ and faunal remains²⁰ from the site. The continuous reuse of the hearth basin suggests it was likely regularly re-cut, raked out, and re-deposited with mixed sediments, making the links between the hearth and occupation levels hard to establish with certainty. Apart from the hearth complex, the excavators have divided the recognized levels into two groups. Levels of relatively limited spatial extent (<4 m²) were confined to the back of the shelter. The rear layers close to the shelter wall were generally looser and often with more abundant artifacts than the layers closer to the front of the shelter. This is particularly true of the lower portion of the sequence in the back of the shelter (Levels 7, 7a, 11, 12, 16, and 17). Some of the layers were likely, at least in part, water-deposited (Levels 5 and 5a). The rear layers are seen more as refuse areas while the front layers, basins, and pits can probably be best interpreted as individual episodes of occupation. The front levels were more extensive horizontally (around 10–15 m²) and thin out towards the south, likely representing occupational floors. The provenance of discovered finds is marked first by the designation of the 1 by 1 m quadrant as a combination of a letter and a number referring to the grid shown in Fig. 6, followed by a

letter of the subquadrant (A, B, C, or D), and finally a number or combination of a number and a letter designating the level.²¹

Table 1. Description of excavated levels at Badanj, 1986-1987 excavations. Modified after Whallon 1988 cited by Miracle 1995, Appendix I. Numbers in square brackets in the fourth column indicate the number of identified flint tools, cores and core by-products found in each of the unmixed levels (after Whallon 1999, Table 31.1).

Level	Extent, color, and consistency	Features	Archaeological material
1	Generally gray in color, varying to gray-brown or brown in a few places, and showing only occasional spots of a more reddish cast. In most areas, the gray or gray-brown earth of this level was mixed with a moderate amount of small, angular rocks (<i>éboulis</i>).		A moderate amount of archaeological material, representing a mixture of several periods, resulting from disturbance of this deposit, partly by what appeared to be modern ash and fireplaces. [431]
2	Clearly distinguishable as a relatively soft, loose, red, reddish, or reddish-gray deposit, containing less angular <i>éboulis</i> than Level 1. Near the rear, this level was more fine-grained, humic, and more moist, changing in color to a brown or yellow-brown (sq. I-K, 5-6), although this occurred as a gradual gradation from the characteristic red color of the level further to the front, rather than as an abrupt change. At the very front of the site, the typical red of this level became a reddish gray and finally gray.	In a number of areas where ash was found to be mixed into the earth of Level 2, there were found occasional patches of ash and ash mixed with snail shells. However, these appear to originate largely in earlier levels and to have been incorporated into Level 2 by disturbance of these earlier deposits during the occupation of Level 2. The top of one of the major features of several earlier occupations (perhaps all in this area of the site), a large, deep, hearth complex, appears already at the base of Level 2 (sq. J-K, 6-7).	Moderate amount of archaeological material, but different from Level 1, it appears to be <i>in situ</i> for the most part. [621]
5	Limited to the northeast corner of the excavation area, near the back wall of the shelter (sq. J-K, 5-6). Fine, yellow-brown silts, with no, or extremely small number of <i>éboulis</i> inclusions. It looks very much like a water-deposited sediment.	Level 5 clearly overlay not only the large hearth complex but also Level 2a.	[155]
2a	Consists almost entirely of a large concentration of soft, gray ash. In a few cases, the deposit seems to consist primarily of soft, gray ash, with few or no snail shells, but the inclusion of moderate quantities to abundant masses of snail shells, many of which are unbroken, is typical of this layer. In one or two spots, particularly in sq. I5, against the back wall of the shelter, there is more earth in the deposit, and it is a brown to dark brown color, although it remains soft and full of snail shells.	The bulk of this concentration occurs in a large, relatively deep pit, or complex of pits, to the rear of the shelter (from row 8 to the rear) and particularly in the northwest, rear corner of the excavation area (sq. I5-7, J5-6). The very last phase of intense use of the large hearth complex in sq. J-K, 6-7 appears probably to have been associated with Level 2a.	Snail shells (the largest concentration of all levels), flint, and bone. Some separate pockets of pure, gray ash occurring at the same physical level as Level 2a, in sq. J-K9 and J-K,10-11, were sterile and were not considered to be part of Level 2a. [492]

2b	Level 2 deposits were so deep in sq. I5-6 that a lower division was created. This division was at first entirely arbitrary, but in looking at the remaining rear wall profile along the 4/5 m line, these lower ash and snail shell deposits look reddish in contrast to the real gray, which is characteristic of Level 2a. This difference may not be greatly significant in depositional/occupational terms, and it otherwise looks as though 2a and 2b together represent a single occupation phase.		Snail shells, flint, and bone. [104]
Hearth	Stratigraphic divisions within the hearth complex were distinguished primarily on the physical character of its deposits.	In the course of the building up of this complex, there appear to have been stages during which particularly long or intense fires were made that created heavily burned and fused deposits. Some four such phases were observed, which serve to divide the complex into four major divisions: The Top Hearth, Upper Hearth, Lower Hearth, and Basal Hearth.	The nature of the materials within the hearth does not appear to vary significantly throughout the sequence of its use and re-use.
3	A very red layer - sometimes being a bright red, but more usually occurring as simply a red or reddish, light, soft, fine, even powdery deposit, with relatively much <i>éboulis</i> . Level 3 grades at its outer edge from red to gray, brownish gray, or gray-black, usually slightly darker (or a bit more compact) than Level 2.	To the rear, Level 3 has been cut into by the pits of Level 2a.	[587]
5a	Reddish brown to brown, silt deposit in the rear of the shelter. It was generally distinguishable from the overlying Level 5 by its darker color, although in a number of places this distinction was very difficult to make in excavation, leading to some possible confusion of the two in these spots. The nature of the sediments in this layer varies vertically. At the top, Level 5a is uniformly pure silt, with little or no <i>éboulis</i> or snail shell inclusions. However, irregularly, here and there, it was found to become mixed with some <i>éboulis</i> , snail shells, etc., being more compact, also, in these parts. Elsewhere, both above and below such areas, it remains pure silt. At the very bottom of the level, over most of its area in sq. I-K5, it was filled with large masses of very light, porous but compact, yellow (and occasionally gray) material.	Level 5a clearly interfingered with deposit of the hearth. An interdigitation of Level 2a deposits with the upper part of Level 5a can be seen in the 4/5 m profile at the rear of the site. Level 5a becomes extremely thick in places, in conformity with the interpretation that it represents a long sequence of accumulation continuing during the deposition of more than one other stratigraphic unit beside (west) and in front of it. This is tentatively identifiable as redeposited loess, washed in from the surface on the hill above the shelter, and evidently represents some rather specific depositional/climatic conditions near the beginning of the accumulation of this layer. Generally speaking, though, the predominantly silt composition of Level 5a seems to argue, as in the case of Level 5, for water as the agent of deposition here and an interpretation of this layer as a natural (geological) accumulation of material washed into the rear of the site, rather than an occupation level (or midden deposit).	[170]
4	Mostly reddish-brown in color, with frequent variations toward reddish gray on the one hand, or, less often,	Where Level 4 meets the hearth complex, it does not interfinger with hearth deposits, which seem, rather, to cut into the level	Lots of flint and bone. [486]

	darker red. The front edge of Level 4 became darker, being brownish gray to dark gray, for some 0.5-1 m prior to its termination against sterile, yellow <i>éboulis</i> . The sediments of Level 4 were typically unconsolidated and contained relatively large amount of <i>éboulis</i> , and occasionally snail shells, especially in sq. I6-7.	forming a basin (as also is the case with Level 3).	
7	Confined to the northwest rear corner of the excavation area. It was a very loose, dark, gray to almost black deposit, with perhaps fewer <i>éboulis</i> inclusions than Level 4 or 5, but of a less silty, coarser texture than Level 5a. It was clear in excavation that Level 7 terminated tapering out on top of underlying Level 6, seemingly ending originally thus, rather than having been cut into and truncated or removed by later occupations.	In character it looked very like an occupation layer, similar to the more extensive ones that extended fully forward to the sterile <i>éboulis</i> at the front of the site.	Relatively abundant archaeological materials, among which it was notable that the bones seem to be of noticeably larger size than usual in other levels. [491]
6	Covered most of the excavation area except in those places where it had been cut into by the hearth complex. It was gray in the front of the site (from sq. I-K/8 forward), becoming more red-brown (sq. I6-8), and finally a dark reddish to clear, bright red color (sq. I5, J5-8, K5) through the middle and towards the rear of the site. In most places it consisted of a soft and loose sediment, with moderate to abundant amounts of <i>éboulis</i> inclusions. The level terminated in the front of the site on sterile, yellow <i>éboulis</i> .		Significant amounts of archaeological material. [642]
7a	Restricted to the northwestern corner of the excavation area, underneath Level 6. It was a very loose, unconsolidated deposit, very dark in color, being very dark gray, gray-black, to black, and being described at points as "greasy."	Given its size and location, it is impossible to think of this level as a true occupation layer in the same sense as the horizontally more extensive levels.	Very abundant archaeological material and bones in this layer appeared noticeably larger than in most other levels, similar in this respect to Level 7. [141]
8	Consisted of soft, loose deposits that were characteristically light gray-brown in color. It was notably thin in most parts, and contained a moderate amount of <i>éboulis</i> . Toward the rear of the site, this level seemed either to taper out and end or to have been cut into by Level 7a.	Level 8 extended over the area in front of the hearth complex and along the west side of the excavation area, beside the hearth. The Basal Hearth seemed to cut cleanly into Level 8 over a large area. It appears to be an occupation layer, and terminates in front on sterile, yellow <i>éboulis</i> as do other such layers.	Moderate amount of archaeological material. [184]
9	Almost identical to Level 8 and was distinguished from the overlying level by its slightly darker gray to gray-	Where Level 9 and the Basal Hearth touch, their deposits intermingle, and this layer is not	[435]

	brown color. It is also a generally thicker layer.	cut into cleanly by the hearth complex as is Level 8.	
10	Definitely darker and more gray in color. It was similarly loose in texture, containing a light to moderate amount of <i>éboulis</i> . It was of variable thickness, and was extremely thin in places. Level 10 covered about the same area as overlying Levels 8 and 9, but it was unusual in reversing the trend of the steady retreat of the front edge of lower stratigraphic levels. It was noted in excavating this layer that in some places a noticeable amount of light brown sediment like that of Level 14 was mixed in patchily with Level 10.	This level exhibited a variable relation to the Basal Hearth, interfingering with it in some places, but apparently cut through by the hearth elsewhere.	Occasionally, relatively large amounts of flint and bone. [435]
14	Predominantly yellow-brown to light brown in color, clearly distinguishable in this respect from the overlying Level 10. Moderately compact, rather than loose and unconsolidated like the overlying level, although it did contain moderate to abundant amounts of small <i>éboulis</i> . In extent, this level was restricted to the front of the excavation area.	Along much of its rear edge, it was cut into and truncated by the Basal Hearth. However, along the western side of the excavation it could be seen that Level 14 thinned out and ended naturally about half-way back into the shelter. In the front, this level began once again the progressive retreat of the outer edge of the site.	[248]
11	Found in at the rear of the shelter, particularly in the northwest corner of the excavation. It was characteristically a red to dark red layer, although it darkened to a red-black or even black color in a few small areas. The sedimentation in this layer ranged from loose to moderately compact (always more compact than Level 7a above it) and were somewhat silty.	It appeared clearly to be a cultural deposit, rather than of geological origin, although not a major occupation area, given its restricted size.	Level 11 consistently contained a notably high density of bones and flints. [434]
11M	Has the appearance of a highly mixed deposit (thus the designation "M"), consisting of a loose, silty, gray to gray-brown, ashy deposit. Level 11M was found in back of Level 11, against the shelter wall, and to the east of Level 11, in the northeast corner of the excavation, behind the hearth complex.	The transition between levels 11 and 11M was rapid, but not sharp. There seemed to be always some intermingling of the two levels, which led to their designation by the same level number, strongly differentiated, however, in terms of the nature of their sediments and what they likely represent depositionally.	Filled with both archaeological material and snail shells.
12	Restricted to rear 1 to 1.5 m of the excavation area, where it formed a wedge overlying and apparently partially cutting into the underlying Levels 16 and 17. To the northeast, Level 11M clearly had, in its turn, cut in Level 12. Level 12 plunged deeply in the northwest corner of the excavation, forming an extremely thick layer in the very small area behind the rock in sq. I5. This was a very loose, unconsolidated level, filled with much <i>éboulis</i> . In color it was dark, mostly dark reddish brown to dark brown.		It was filled with flint, bone, and, especially near the rear wall of the shelter, snail shells. [595]
13	Extended broadly over the front of the	Its relationship to the Basal Hearth was	[891]

	excavation, reaching at its surface as far, or almost as far, forward as Level 14 above it, but showing at its base a significant retreat of the area covered by archaeological layers over this part of the site. It was a relatively thick layer, of brown earth, which was darker toward the rear of the shelter, stained slightly red near its contact with Levels 16 and 17, becoming lighter and more gray-brown toward the front. There was a great deal of small <i>éboulis</i> included in the sediments of this layer, and on the east side of the excavation, these <i>éboulis</i> were strikingly white in color, rounded, and soft, giving a strong impression that they had been heavily weathered.	variable, being intact underneath the hearth in places, but clearly having been cut onto here and there by the hearth as well. At the rear of the shelter, Level 13 abutted Levels 16 and 17 directly, all three levels appearing to be stratigraphically equivalent, but with rather sharp boundaries among them all, with no evident intermingling or interfingering of their respective deposits. Level 13 seems to be a broad occupation layer, and perhaps Levels 16 and 17 can be seen also to belong to a complex of levels that can be considered together to represent the deposits left from a single, major phase of occupation of the site.	
16	Restricted to the northwest corner of the excavation area. It was dark brown to brown-black, with a reddish cast to it. It was very unconsolidated and filled with a great deal of small and larger <i>éboulis</i> .	It matched Levels 13 and 17 stratigraphically, but abutted them, as described above, rather than intergrading with them.	Abundant flint artifacts and bones, which appeared during excavation to be larger in this layer than usual. [193]
17	A relatively small unit in the northwest, rear part of the excavation, occurring in back of the hearth and between it and Level 16 to the west. The sediment of this layer was distinctively red, fine, and very soft, often powdery. It contained little <i>éboulis</i> .	It contrasted sharply in various characteristics with Levels 16 and 13, although it appeared to lie stratigraphically adjacent to these levels rather than to over- or underlie either of them.	A good deal of smaller archaeological material, and, near the rear wall in sq. K5, many whole snail shells. [125]

Absolute Chronology

There are currently only five available radiocarbon dates from Badanj (Table 2). Two measurements were obtained immediately after the 1986–1987 excavations and were made on burnt bones. OxA-2196, from bottom-of-the-sequence Level 13, possibly provides a representative date for the start of the sequence in the Oldest Dryas (Fig. 9). OxA-2197 comes from the middle part of the sequence, Level 6, and falls into the duration of the Bølling interstadial.²² In the mid-1990s, another burnt bone sample from Badanj was submitted to Oxford for dating by Geoff Bailey, along with samples from Palaeolithic sites in Epirus.²³ The sample came from Level 4, which is younger than Level 6 in the stratigraphic sequence, but the obtained result (OxA-5895, Table 2) was surprisingly early, corresponding with the date earlier obtained for Level 13. The only explanation of this discrepancy is that some residual material from earlier levels ended up in the assemblage of bones in Level 4. Future, more robust dating and careful selection of dating material (e.g., articulates or matching unfused epiphysis and diaphysis of young animals, both indicative of freshly deposited carcasses that minimally moved after deposition) from various levels at the site will allow for the building of a more reliable absolute chronological framework.

As part of our analysis of the osseous material from Badanj (see below), we have submitted nine samples for dating to the Oxford Radiocarbon Accelerator Unit in September 2018 and August 2019. Apart from one sampled barbed point (inv. 10016, Table 1) and two unmodified bones from levels 2a and 3, which came from the 1986–1987 excavations at Badanj, the rest of the samples come from the collection unearthed by Basler in 1976–1979. Two samples were taken on two incised bones (Fig. 11) and both were withdrawn due to the low collagen yield (%N 0.22 and 0.25 respectively, i.e., below the Oxford Laboratory's minimum threshold). One sample (P-48056) was taken on a perforated red deer canine ornament (Fig. 17:10) and its dating failed, while one sample on an unmodified red deer molar from the depth of 1.3–1.4 m in quad. XXII/II produced OxA-39631, which provides the range of 14,310–13,310 cal BP (95% confidence). Another two samples were taken from two specimens of barbed points (possible harpoons but see below for more details) (Fig. 12), and both produced comparable dates (Table 2). After the calibration using OxCal v.4.3.2,²⁴ OxA-38111 gave the range of 13,310–13,110 cal BP (95% confidence) and OxA-X-2796-45 gave the range of 14,220–13,310 cal BP (95% confidence), with the two measurements not overlapping. The precision of OxA-X-2796-45, which has large error terms, was somewhat affected due to the low pretreatment yield of collagen (%N=0.43, i.e., below the Oxford Laboratory's minimum threshold), even though it is in all likelihood earlier than OxA-38111. While the barbed point dated by OxA-38111 has no stratigraphic information, it is very likely that similar to other barbed points discovered during the first and second excavation phases, it also comes from upper levels in the sequence of the site (see below), and thus represents a date of the final Epigravettian use of Badanj. The barbed point inv. 10016 dated by OxA-X-2796-45 comes from Level 6 in quadrant J5B next to the hearth complex in the back of the shelter, and is in a broad agreement with another previously obtained measurement (OxA-2197), which came from the same level. One lower left human canine found in the Badanj collection with no contextual information was also directly AMS-dated, producing a Late Roman period date – OxA-39697 provides the range of AD 255–415 (Table 2).

The existing and newly available dates might be representative of the span of the Late Upper Palaeolithic use of this site. However, there is an increasing need to provide a more robust chronological framework for the occupation of Badanj, and this can be achieved by planned future targeted AMS dating of preserved organic remains from the site.

Table 2. All radiocarbon measurements and recently AMS-dated failed samples from Badanj, and relevant AMS dates from other Epigravettian sites/levels in the Eastern Adriatic catchment zone.

Lab ID	Material	Context	Radiocarbon date BP	$\delta^{13}\text{C}$	$\delta^{15}\text{N}$	CN	Calibrated date cal BP (95%)	Posterior density estimate cal BP (95%)	Source
Badanj									
OxA-39697	Human tooth (C lower left)	No information	1696±19	-19.6	7.4	3.2	1695-1535	-	This paper
OxA-38111	Red deer antler, barbed point (inv. 7263)	No information	11,320±55	-20.4	2.4	3.3	13,310-13,110	13,320-13,110	This paper
OxA-X-2796-45	Red deer antler, barbed point (inv. 10016)	Level 6, quad. J5B6	11,870±190	-20.3	-	3.3	14,220-13,310	14,140-13,340	This paper
OxA-39631	Red deer molar	Quad. XXII/II, 1.3-1.4 m (01/11/1978)	12,170±55	-20.0	6.4	3.5	14,310-13,810	14,310-13,810	This paper
OxA-5859	Charred bone	Level 4, quad. J9D4	13,200±100	-21.7	-	-	16,180-15,560	16,140-15,530	Bronk Ramsey <i>et al.</i> 2002, 33
OxA-2197	Charred bone	Level 6, quad. I7B6	12,380±110	-21.1	-	-	14,920-14,030	14,910-14,030	Whallon 1999
OxA-2196	Charred bone	Level 13, quad. I7C13	13,200±150	-18.4	-	-	16,300-15,380	16,210-15,350	Whallon 1999
P-46030	Incised bone (inv. 10022)	Quad. K9D4	Withdrawn (%N=0.22)	-	-	-	-	-	-
P-48056	Red deer canine (perforated)	XV/5, 6, 7 (<i>osipina u XV</i>)	Failed (%N=0.42)	-	-	-	-	-	-
P-46031	Incised bone (inv. 7602/1)	Quad. XIV/6, 0.8-0.9 m	Withdrawn (%N=0.25)	-	-	-	-	-	-
P-48053	Red deer metacarpus	Level 2a, quad. I7D	Withdrawn (%N=0.14)	-	-	-	-	-	-
P-48054	Red deer prox. metatarsal	Level 3, quad. K8C	Withdrawn (%N=0.15)	-	-	-	-	-	-
Crvena Stijena									
OxA-23313	Red deer, M3 and the left-side mandible	Layer VIII	11,755±55	-	-	-	13,730-13,460	-	Mercier <i>et al.</i> 2017
OxA-23343	Red deer, lower I1, left	Layer X	11,790±50	-	-	-	13,740-13,480	-	Mercier <i>et al.</i> 2017
Mališina Stijena									
OxA-1894	Charred bone	Layer 3b1	13,780±140	-26.0	-	-	17,100-16,240	-	Hedges <i>et al.</i> 1990, 214
Blazi Cave									
Beta-426508	Charcoal	Layer 2-3, (Trench 5)	11,100±40	-	-	-	13,080-12,820	-	Hauck <i>et al.</i> 2017
Beta-426506	Charcoal	Layer 2 (Trench 5)	14,400±50	-	-	-	17,750-17,340	-	Hauck <i>et al.</i> 2017
Beta-426501	Charcoal	Layer 3 (Trench 5)	15,360±50	-	-	-	18,770-18,500	-	Hauck <i>et al.</i> 2017
Beta-426504	Charcoal	Layer 3 (Trench 5)	15,140±50	-	-	-	18,580-18,230	-	Hauck <i>et al.</i> 2017
Konispol									
Beta-56414	Charcoal	VIII/28	11,410±80	-	-	-	13,420-13,090	-	Harrold <i>et al.</i> 1999
Vela Spila									
Vera-2346	Charcoal	8/6	12,260±40	-	-	-	14,380-14,010	-	Farbstein <i>et al.</i> 2012

Vera-2345	Animal bone	8/6 (NYT)	12,290±40	-	-	-	14,490- 14,050	-	Farbstein <i>et al.</i> 2012
Z-3989	Charcoal	LUP-G (Ly 16)	12,700±100	-	-	-	15,500- 14,650	-	Farbstein <i>et al.</i> 2012
Z-3991	Charcoal	LUP-E (Ly 24)	13,300±100	-	-	-	16,280- 15,700	-	Farbstein <i>et al.</i> 2012
Z-3992	Charcoal	LUP-D (Ly 32)	14,100±100	-	-	-	17,490- 16,800	-	Farbstein <i>et al.</i> 2012
Zemunica									
Beta-218732	Charcoal	SJ143	11,740±90	-	-	-	13,760- 13,410	-	Šošić Klindžić <i>et al.</i> 2015b
Kopačina									
Z-2404	Animal bone	20-40 cm	11,980±270	-	-	-	14,910- 13,290	-	Obelić <i>et al.</i> 1994
Z-2403	Animal bone	140-160 cm	13,160±310	-	-	-	16,800- 14,780	-	Obelić <i>et al.</i> 1994
Vlakno									
Beta-423618	Herbivore bone	Stratum 4	10,270±40	-	-	-	12,370- 11,820	-	Cvitkušić <i>et al.</i> 2018
Beta-416303	Herbivore bone	Stratum 4	10,380±40	-	-	-	12,420- 12,060	-	Cvitkušić <i>et al.</i> 2018
Beta-363142	Herbivore bone	Stratum 4	10,970±50	-	-	-	12,990- 12,720	-	Cvitkušić <i>et al.</i> 2018
Z-3932	Herbivore bone	Stratum 5	11,300±150	-	-	-	13,450- 12,830	-	Cvitkušić <i>et al.</i> 2018
Beta-385285	Herbivore bone	Stratum 5	11,710±40	-	-	-	13,600- 13,440	-	Cvitkušić <i>et al.</i> 2018
Beta-414467	Herbivore bone	Stratum 5	12,080±40	-	-	-	14,080- 13,770	-	Cvitkušić <i>et al.</i> 2018
Beta-414278	Herbivore bone	Stratum 5, above tephra	12,100±40	-	-	-	14,110- 13,790	-	Cvitkušić <i>et al.</i> 2018
Beta-277309	Herbivore bone	Underneath tephra, SU 4	12,350±70	-	-	-	14,790- 14,080	-	Vujević, Parica 2011
Zala									
Beta-228734	Animal bone	12	13,840±50	-	-	-	16,990- 16,500	-	Karavanić <i>et al.</i> 2007
Beta-334805	Animal bone	102	13,340±60	-	-	-	16,250- 15,830	-	Šošić Klindžić <i>et al.</i> 2015a
Beta-334806	Animal bone	100	14,100±60	-	-	-	17,240- 16,920	-	Šošić Klindžić <i>et al.</i> 2015a
Ljubićeva pećina									
LTL5775A?	?	?	13,017±65	-	-	-	15,820- 15,300	-	Oros Sršen <i>et al.</i> 2014
GrA-40926	?	Horizon C (niveau 4)	11,350±50	-	-	-	13,300- 13,090	-	Percan <i>et al.</i> 2009
Beta-249371	?	Horizon C (niveau 3)	13,230±70	-	-	-	13,280- 12,950	-	Percan <i>et al.</i> 2009
Vešanska Peć									
Beta-127706	Charcoal	II/3	11,410±90	-	-	-	13,430- 13,080	-	Miracle, Forenbaher 2000
Beta-120275	Charcoal	II/3A	11,530±50	-	-	-	13,470- 13,270	-	Miracle, Forenbaher 2000

OxA-8448	Charcoal	IX	12,490±100	-	-	-	15,110-14,210	-	Miracle, Forenbaher 2000
Pupičina Peć									
OxA-8449	Charcoal	39.1 (Horizon T2b)	10,140±180	-	-	-	12,410-11,230	-	Miracle 2005
Beta-131626	Charcoal	33	10,150±60	-	-	-	12,060-11,400	-	Miracle 2001
Z-2574	Charcoal	31, 32, 34	10,610±200	-	-	-	12,960-11,830	-	Miracle 1997
Beta-188919	Charcoal	Horizon S	10,280±50	-	-	-	12,380-11,820	-	Miracle 2005
Beta-145095	Charcoal	373.1 (Horizon U+V)	11,150±80	-	-	-	13,160-12,790	-	Miracle 2005
Z-2636	Charcoal	207	11,160±270	-	-	-	13,570-12,590	-	Miracle 2001
Nugljanska Peć									
OxA-X-2462-22	Charcoal	6	11,160±50	-	-	-	13,130-12,870	-	Pilaar Birch, Miracle 2015
Beta-127705	?	8	11,520±90	-	-	-	13,550-13,160	-	Miracle, Forenbaher 2000
OxA-X-2462-22	?	8	12,510±55	-	-	-	15,090-14,330	-	Pilaar Birch, Miracle 2015
Šandalja II									
GrN-4976	Animal bone	B/g	10,830±50	-	-	-	12,800-12,670	-	Malez, Vogel 1969
OxA-26874	Bone	B/g	12,295±55	-	-	-	14,620-14,040	-	Oros Sršen <i>et al.</i> 2014
KIA-23489	Human bone	B/s	11,025±60	-	-	-	13,040-12,740	-	Richards <i>et al.</i> 2015
GrN-4978	Charcoal	B/s	12,320±100	-	-	-	14,880-13,990	-	Malez, Vogel 1969
Z-2421	Animal bone	B/d	10,140±160	-	-	-	12,390-11,250	-	Obelić <i>et al.</i> 1994
CAMS-12062	Charcoal	B/d	10,990±60	-	-	-	13,010-12,720	-	Miracle 1995
OxA-26872	Bone	B/C	12,035±55	-	-	-	14,050-13,750	-	Oros Sršen <i>et al.</i> 2014
OxA-26871	Bone	B/C	12,680±55	-	-	-	15,290-14,820	-	Oros Sršen <i>et al.</i> 2014
Z-2423	Animal bone	B/C	13,050±220	-	-	-	16,300-14,980	-	Obelić <i>et al.</i> 1994
OxA-26870	Bone	C/s	11,515±50	-	-	-	13,460-13,260	-	Oros Sršen <i>et al.</i> 2014
OxA-26869	Bone	C/s	12,940±55	-	-	-	15,710-15,250	-	Oros Sršen <i>et al.</i> 2014
Z-2424	Animal bone	C/s	13,120±230	-	-	-	16,240-15,070	-	Obelić <i>et al.</i> 1994
Romualdova									
Beta-465337	Charcoal	?	10,880±30	-	-	-	12,800-12,690	-	Ruiz-Redondo <i>et al.</i> 2019
Beta-	Charcoal	?	13,970±50	-	-	-	17,180-	-	Ruiz-

465338							16,690		Redondo <i>et al.</i> 2019
OxA-36127	Charcoal	?	14,250±80	-	-	-	17,600-17,090	-	Ruiz-Redondo <i>et al.</i> 2019

Chipped stone tools

Basler²⁵ reported a rounded total of 250,000 flint artifacts from a relatively small trench that he excavated around the engraved rock. Scrapers, usually circular- or thumbnail-shaped, predominated, making up 48% of the assemblage. Microgravettes are the second dominant class of tools with 26% of the total assemblage. Below the area of the 1976–1979 excavations, beneath thick levels of sterile *éboulis*, there are reports of Middle Palaeolithic artifacts²⁶ but there is currently limited information about the possible existence of levels older than the Upper Palaeolithic.

There were in total 7860 knapped stone artifacts from the 1986–1987 excavation seasons, excluding the material found in likely mixed contexts of the hearth complex and Level 11M. Analysis of the lithic material from the 1986–1987 excavations has shown that within the general “Epigravettian” lithic industry (Fig. 10), widespread across Mediterranean Europe from southern France to Greece, there are several diachronic trends, suggesting at least two distinct phases in the sequence – early and late, with the transition occurring roughly in the middle of the sequence between Levels 6 and 7a.²⁷ The following observations have been made about marked differences between these two periods: (1) predominance of backed bladelets with straight or slightly curved backs in the Early period in contrast to a predominance of thumbnail or “circular” scrapers in the Late period; (2) backed bladelets with noticeably curved backs are more a characteristic of the Late period; (3) backed blades and both small and large backed flake points are more frequent in the Late period; (4) geometric microliths (mostly crescents/segments, with about half as many triangles) are exclusively restricted to the Late period; (5) there is a decline of end-of-blade scrapers and large, massive sidescrapers from the Early to Late period; (6) truncations are more common in the Late period.²⁸

Apart from these trends, one could also note that there is only one reported shouldered piece for the whole assemblage excavated in 1986–1987.²⁹ Well-prepared prismatic or pyramidal cores are rare, often these are poorly prepared and highly exhausted. There are also abundant splintered pieces (*pièces esquillées*), made by knapping on hard surfaces with bipolar flaking techniques, which are interpreted as a form of cores for microblades. A spatial analysis of the distribution of lithic finds for representative Level 6 suggests differences between the rear and front of the shelter: a range of tools, such as thumbnail endscrapers and borers in the rear of the rockshelter, close to the area of the hearth complex in the well-sheltered zone, suggests a range of domestic, small-scale craft activities, while end-of-flake scrapers and likely armatures (microgravettes, segments) were concentrated in the front of the shelter, possibly suggesting hide and skin processing activities, as well as activities related to the repair of hunting gear.³⁰

Comparison of the Badanj lithic assemblage with those in adjacent regions provides close parallels between Badanj and the assemblages in Apulia, southern Italy. For instance, the same trend seen at Badanj with regard to the dominance of backed bladelets in the early Epigravettian phases in contrast to the dominance of thumbnail or “circular” scrapers in the later phases is also found in southern Apulian sites (e.g., Romanelli, Taurisano, Fig. 1). The other similarity between the two regions is the recurrent presence of splintered pieces in both regions. One of the key differences between these assemblages, however, is the absence of microburins at Badanj and their persistence in the Italian Epigravettian assemblages. It is interesting to note that similarities in the character of the lithic assemblage between Badanj and southern Apulia are not shared with northern Apulian sites, such as Grotta Paglicci, in the Gargano peninsula (Fig. 1), even though this area is geographically closer to Badanj.³¹

The earliest Upper Palaeolithic level at Crvena Stijena, Montenegro, to the east of Badanj, massive Layer X, has now also been AMS-dated with one measurement to around 24 kya cal BP,³² which would correspond with the duration of the LGM. However, this layer also produced an Epigravettian-age date of 13,740–13,460 cal BP, while a date of similar Epigravettian age also originates from stratigraphically younger Layer VIII. This may suggest problems with the integrity of stratigraphic levels at Crvena Stijena as defined during the first excavations of the site,³³ with the likely presence of intrusions into earlier levels. Layer X was very thick, and four major subdivisions within it were recognized even in Basler’s early excavations. The assemblages of lithic artifacts from these subdivisions of Layer X are too small to allow their clear typo-chronological definition, and the distinct possibility of intermixing of materials from the uppermost subdivision Xa and Layers IX and VIII above has been noted.³⁴ There are bipolar cores at Crvena Stijena in Layer X as well as cores for small bladelets. Among tools, there are bladelets and points with straight back, burins, and retouched blades, as well as notched tools and truncations. These elements may suggest a dating consistent with the period preceding the earliest assemblages at Badanj, which would correspond well with the respective characters of the assemblages from Layers X-VIII at Crvena Stijena, but a better grip over the chronology of this range of occupations at Crvena Stijena is badly needed.

On the other hand, Layers IX and VIII at Crvena Stijena are characterized by the presence of arched backed bladelets and geometric tools. It seems that similar to the observed diachronic trends in the character of the lithic assemblage from Badanj, circular endscrapers appear in small frequency in Layer IX and are much more present in Layer VIII. Layer IX contained frequent large-sized points. Also, arched backed bladelets and clearly shaped geometric tools (segments, lunates, triangles), backed truncations as well as short circular and thumbnail endscrapers are all more prominent in Layer VIII, which would, similar to the Late period at Badanj, correspond to the Bølling/Allerød interstadial. The one available date for Layer VIII at Crvena Stijena (Table 2) agrees with this as well. The similarity is also seen in the presence of splintered pieces in Layer IX at Crvena Stijena. On the other hand, geometric tools, segments and triangles, disappear in Layers VII-VI, although other microlithization trends continued.³⁵ It has been suggested that Level VI at Crvena Stijena may possibly be correlated with Badanj levels 2a and 2b, which may be of Early Holocene date,³⁶ but currently we lack any further support of this claim.

The sites of Mališina Stijena and Medena Stijena, found close to each other in the canyon of the Čehotina River in northern Montenegro (Fig. 1), have also yielded lithic tool types that can be associated with Epigravettian traits. At Mališina Stijena, layer 3b1 has been dated with only one date so far to c. 17,100–16,240 cal BP (Table 2), corresponding to the date for the Early phase at Badanj. The lithic industry here is characterized by straight backed bladelets, endscrapers, and burins on blades and flakes. Younger layer 2 is characterized by backed bladelets (some of which are arched), endscrapers on short blades and shouldered blades.³⁷ There are currently no radiocarbon dates for Medena Stijena, where in Upper Palaeolithic levels, Layers IX and X, there were straight backed bladelets, retouched blades, and massive endscrapers and burins, while backed points and a large number of nosed endscrapers on flakes were found in Layer VIII. Chronologically later Layers VII-V contained an industry that may correspond to the pattern seen in the Late period at Badanj, with a large number of thumbnail and circular endscrapers, arched backed bladelets, backed truncations, and geometrics (triangles, lunates).³⁸ Finds from lower levels of the site of Trebački Krš, situated in eastern Montenegro (Fig. 1), may also correspond to the Epigravettian period with the presence of backed bladelets, some of which were arched, and endscrapers.³⁹ A major difference between the assemblage at Badanj and Montenegrin sites relates to the absence of burins at Badanj. There is also a more restricted range of tools at Badanj than at Montenegrin sites. On the other hand, massive arched points and bilaterally retouched backed bladelets common at Badanj are completely absent in Montenegro.⁴⁰

Some similarities with the lithic assemblage from Badanj can also be found in the broadly contemporaneous sequence at Klithi in Epirus,⁴¹ for instance in the presence of backed bladelets with straight and slightly curved backs. Yet there are also differences—at Klithi, there is the absence of splintered pieces, which are common at Badanj. Another difference is the presence of the microburin technique at Klithi. In addition, burin spalls frequent at Klithi are absent at Badanj.⁴²

Finally, there is a rich Epigravettian lithic assemblage excavated and reported from the cave site of Blazi in Albania (Fig. 1) dated to the later phases of the LGM (ca. 18.5–17 kya cal BP, Table 1),⁴³ thus preceding the sequence at Badanj on the face of the current dating evidence. However, it is of interest to note that at Blazi, similar to the sites in Epirus, burin spalls are present in the assemblage dominated by straight unilaterally backed microblades and bladelets. Microgravettes are also present and microblade cores are common. Splintered pieces are also found in very small quantities, similar to a small number of fan-shaped, circular, and thumbnail endscrapers. In addition, at the currently undated, near-coastal site of Kanali in Albania (Fig. 1), the presence of geometric microliths seems to indicate a later Epigravettian phase.⁴⁴

Faunal Remains

Apart from the information that the collection of faunal remains from the 1976–1979 excavations at Badanj was studied by B. Sala from the University of Ferrara,⁴⁵ there is no other mention of the faunal

remains and the composition of the assemblage from this excavation phase.

The material from the 1986–1987 excavations was analyzed by Preston Miracle and presented in his unpublished Ph.D. dissertation.⁴⁶ Spatially, there are differences between the front and back levels of the shelter in mammalian species composition while, at the same time, changes also occur over time. The most abundant hunted species are red deer, chamois/ibex (*Rupicapra/Capra* sp.), roe deer (*Capreolus capreolus*), hare (*Lepus* sp.), wild boar (*Sus scrofa*), aurochs (*Bos primigenius*), and wild ass (*Equus hydruntinus*). Carnivores (*Vulpes vulpes*, *Canis* sp., *Meles meles*, *Felis silvestris*, *Felis lynx*) are found in small frequencies. The general trend over time from earlier to later levels is the increase in the frequencies of wild boar and roe deer, and a drop in the frequencies of chamois/ibex (from Level 6 onwards). The red deer is steadily present as the staple hunted game species from the very start of the sequence but its dominance increases further from Level 6 onwards. There is a sharp rise in the hunting of roe deer at the end of the sequence (Levels 2 and 1). These major shifts are explained by environmental changes due to the expansion of forest cover at the expense of open karst, the latter being a preferred habitat of chamois/ibex.⁴⁷ This would be expected from warmer climatic conditions of the Bølling/Allerød interstadial into which the later part of the Badanj sequence can be placed (Fig. 9). A small number of identified marmot (*Marmota marmota*) remains are restricted to the lower part of the sequence, which would correspond to the assumed duration of the Oldest Dryas. On the other hand, throughout the sequence, red deer, roe deer, and wild boar remains were more frequently found in the back levels of the shelter while chamois/ibex remains were more frequently found in the front levels. Based on his analysis, Miracle⁴⁸ suggested grouping of different levels in the sequence of Badanj into Upper (Levels 1, 2, 2a/2b, 5), Middle (Levels 3, 4, 5a, 6, 7), Lower (Levels 7a, 8, 9, 10, 11, 12, 14), and Lowest (Levels 13, 16, 17).

In some levels (2a, 5a, 4, 12, and 17), large concentrations of land snails (*Helix* sp.) were found, often next to the back of the shelter. By far the largest concentration was found in Level 2a, and it remains unclear to what extent the accumulation of land snails relates to human or environmental factors.⁴⁹ Very few fish specimens were recovered at Badanj (NISP=21) and the discovered remains are primarily concentrated throughout the Later period of the site sequence, which would correspond well with the appearance of barbed points made from antler, which might have possibly been used as harpoons for fishing in the nearby river around the same time (but see below). Yet, it is unclear whether such a small assemblage of fish bones would justify the presence of barbed points, which also could have been used in targeting game, and we will return later to a discussion of this category of tools and their possible function. Bird bones are similarly rare (NISP=16).

Miracle and O'Brien⁵⁰ examined two types of seasonality indicators in order to suggest the season of occupation of Badanj against the background of existing models of Palaeolithic foragers' seasonal transhumance and likely changes in patterns of forager logistic mobility in periods of significant climatic unpredictability towards the end of the Pleistocene. There were significant and sometimes rapid climatic and environmental shifts during this period that might have had a knock-on effect on the seasonal density and availability of animal herds and displacements of human population from the presumably

productive coastal plain areas, caused by sea level rise, into the hinterland of the Adriatic Basin. Fetal remains of red deer and tooth cementum annulation (TCA) on red deer teeth were examined, considering that red deer is the most dominantly present and thus representative subsistence staple species. While sample sizes for neither of the two methods are particularly large when specimens are disaggregated by different levels of the sequence that spanned several millennia, at face value the data seem to suggest a strong pattern of winter use of the site for targeting hind (female) herds, especially in relation to the Early period (Levels 7, 13) of the sequence. There seems to be a shift in the Late period (Levels 2b, 3, 5a) of the sequence with more variable seasons of occupation as mortality profiles for red deer shifted into the summer and/or fall, which could be in line with changes brought by the onset of the Bølling/Allerød interstadial around 14.6 kya cal BP, the rise of sea levels, and the assumed general shifts in the scheduling of the seasonal rounds of the wider regional resource exploitation and mobility. The targeting of female herds by Badanj hunters in the winter might have stemmed from the decision to obtain prey of relatively fat-rich individuals compared to malnourished male individuals of red deer during the same season.⁵¹ The relative rarity of red deer antlers, restricted to male individuals, throughout the sequence of the site may corroborate the scenario of the preferential hunting of female herds. On the other hand, the presence of some tools made from red deer antlers from Level 6 onwards (see below) suggests that red deer antlers used in manufacturing these artifacts might have been collected as shed antlers, that some male individuals were hunted after all, and/or that these barbed points might have been made elsewhere and brought to the site as finished products.

We will return to a further discussion of the relevance of the examined indicators of the seasonality of site occupation when modeling and reconstructing a wider pattern of forager residential/seasonal mobility in this part of the Adriatic Basin. This discussion will particularly be relevant when considering the availability, use, and frequencies of certain marine gastropods, scaphopods, and bivalves used as personal adornment in the rich assemblage of these items from Badanj.

Materials And Methods

We have examined the largest part of the existing collection of osseous tools and personal ornaments from Badanj but our analysis is not completed at present. Hence the data we present below are preliminary insights with much more detail and a comprehensive coverage to be provided elsewhere. All examined specimens were measured, photographed in several projections with a NIKON D3200 digital camera equipped with macro lens, studied by naked-eye, and further examined using a Colestron Microdirect 1080 HD handheld digital microscope with magnification up to 220x in order to understand feasibility for further techno-functional study. While use-wear and residue analyses are somewhat hampered by the heavy presence of consolidants over the surfaces and writing of museum inventory numbers, a number of artifacts have already been selected for further microscopic examination using both low and high magnification. In addition, in the past, for exhibition purposes, a large number of personal ornaments were strung together, which, for the moment, in some cases prevents their detailed examination. While the osseous materials we examined include specimens found during both 1976–

1979 and 1986–1987 excavations at Badanj, the personal ornaments we analyzed come from Basler's excavations only.

Osseous Tools

Basler⁵² reports a total of 11 osseous tools from the zone he excavated in the late 1970s. In the museum collection, we have found at least 53 osseous tools that come from Basler's excavations at the site. In the course of the 1986–1987 excavations, osseous tools were also found in low frequency compared to flint implements. It has been noted that stratigraphically the rare occurrence of antler barbed points is restricted to the Late period in the sequence, i.e., from Level 6 onwards.⁵³

Pointed tools

A number of bone tools in the examined assemblage are distal parts of pointed tools (Fig. 11). As with other artifacts, doing use-wear analysis is to some extent hampered by the use of consolidants. Based on manufacturing traces, slightly asymmetrical pointed tools, made on medium to large mammal long bone/metapodial diaphysis, are created by invasive flint scraping of the surfaces. No earlier steps in the production sequence can be observed on the specimens we have examined. A large asymmetrical point with a broken tip was likely made from the ulna of a large mammal (Fig. 11:10). Asymmetric pointed tools made from bone are known from our examination of the assemblage of osseous tools found in the Early to Late Epigravettian-dated Layers VIII and VII at the Crvena Stijena rock-shelter in Montenegro (unpublished data). Similar basic shapes can also be found in the assemblage of Early (Layer C/d) and Late (Layer B/d and Complex B) Epigravettian tools from the site of Šandalja II in Istria, Croatia.⁵⁴ Further analogies can be made with the assemblage of bone tools from the Dalmeri rock-shelter in northern Italy (Asiago Plateau), where, along with asymmetric points, numerous projectile points were found as well as blanks made from red deer antler.⁵⁵ There is one tapered point made from a long bone diaphysis (Fig. 11:7) and one symmetric bipoint made from an antler blank (Fig. 11:8). Both of these specimens show developed traces of use. In the course of the Late Upper Palaeolithic, osseous bipoints were widespread across the eastern Alpine region and the eastern Adriatic zone (e.g., Vela Spila). Long tapered points are documented in the Mesolithic layers of Crvena Stijena in Montenegro and in the central Balkans.

A large and fully shaped antler blank (Fig. 11:9), manufactured by double longitudinal grooving along the axis and transversal cutting of its lower, proximal end, is noteworthy. This is likely a roughout, possibly intended for the production of a long projectile point or barbed point. The stratigraphic position of the specimen, which was found in the course of the first excavations at the site at the depth of 1.0-1.1 m, although relatively deep, could still likely be considered roughly at the boundary between the Early and

Late Period of occupation of the site as identified in the area excavated in 1986–1987. Hence it could relate to the production of barbed points made from antler.

Barbed points

All of the examined unilateral barbed points (Fig. 12) were made from red deer antler. There were two to three or more barbs on each specimen. One heavily fragmented specimen (Fig. 12:5) does not have preserved barbs, but we include it in this category on the basis of several traits—it was made from red deer antler, oblique transversal cuts on one side and specific use-fracture indicate that a barb might have been present here, and it has a perforation near its distal end—all of which may tentatively suggest it was a barbed point. The specimens exhibit different morphologies. They are well preserved even though they are affected by taphonomical alterations—discoloration and exfoliation of the surface tissue caused by water action, as well as burning, the latter clearly visible on two specimens (Fig. 12:4-5). No manufacturing traces related to the debitage can be discerned on these specimens as these were scraped out while shaping them, with the exception of one specimen on which longitudinal grooving marks in the shape of deep striations are still visible on the side of the tool where barbs are missing (Fig. 12:3). Overall, double grooving was used for carving all the blanks, which were later regularized by scraping. Barbs were added at the end of the manufacturing process by tracing them first and subsequently cutting them using a flint tool (Figs. 13-14). A large perforation is visible on two artifacts—on one entire specimen where it was carved and, subsequently enlarged by rotation (Fig. 12:1), and on the partly burnt specimen (Fig. 12:5) where it was carved by deep grooving. Yet, it remains unclear what the exact shape of the latter specimen is, and whether it had barbs on the missing, more proximal part of the tool. All specimens show heavy traces of use. There are visible compaction marks and compacted tissue at the base of the AMS-dated specimen 10016 (Fig. 13:1), which in combination with the presence of a perforation close to the base of the same specimen may point to the use of this barbed point as a proper detachable harpoon head inserted into some sort of haft in order to maintain the link between the prey and the hunter. However, we cannot exclude its possible use as a projectile arrow or that it might have been used with a spearthrower.⁵⁶

Here we prefer to use a more neutral term barbed point (designed to obstruct easy extraction from a wound) rather than the commonly used designation “harpoon.” The latter is considered as an operating mode rather than necessarily a particular morphological category of weaponry, i.e., it refers to the mode of predation when a detachable head is attached to a line, “drag,” or impediment that always maintains the link between the prey and the hunter.⁵⁷ Based on his examination of the Upper Magdalenian barbed points against the known function of different morphologies of barbed weaponry among North American ethnographic cases, Pétilion⁵⁸ has shown that morphological features of barbed points (e.g., spurs, or holes on proximal ends of barbed projectiles), often used in making an argument that barbed points were used as detachable harpoon heads, are not sufficient traits for unequivocal distinction between harpoons, which are primarily used in hunting fish, otter, beaver, and other water animals in known ethnographic

examples, and a more general category of barbed projectiles, which could have been used as arrows when hunting large game or even as weapons of war.

With two direct AMS measurements (Table 2, Fig. 9) now available for two barbed points found during both research phases at Badanj, as well as judging by the stratigraphic position of other barbed specimens, it is possible to confirm that this type of tools is confined to the Late period of the Badanj sequence. Specimen 10016, which was found in Level 6 and dated by OxA-2796-45, suggests the likely appearance of this technological innovation already from around 14 kya cal BP to 13.3 kya cal BP, a large span due to large error terms of this measurement. On the other hand, OxA-38111 dates another barbed point specimen (7263), found in Basler's trench but, unfortunately, with no precise contextual details. It gives a more precise measurement that falls into the last centuries of the 14th millennium cal BP (Table 2). Specimen 10037 (Fig. 12:3) was found in Level 2 and it would be expected that it is of even younger date, perhaps pushing its age to the end of the Bølling/Allerød interstadial in the first centuries of the 13th millennium cal BP, or perhaps even later, but this can only be confirmed by future targeted AMS dating if not of this particular specimen then of datable materials from the uppermost levels of the site. For specimens 7264 and 7807, found during Basler's excavations, recorded depths of 0.5-0.6 and 0.6-0.7 suggest that these clearly belonged to the Late period of the stratigraphic sequence.

These new direct AMS measurements provide an unambiguous confirmation that currently the barbed points from Badanj represent the earliest directly dated appearance of this technological innovation in the whole of southeastern Europe, including the Italian Peninsula. After possible early experimentation during the Gravettian period in western Europe with self-barbed points,⁵⁹ barbed points make a significant appearance in the Upper Magdalenian period, from around 16/15.5 kya cal BP to around 14 kya cal BP.⁶⁰ The Badanj harpoons are thus somewhat later and would correspond to the use of barbed points during the Azilian period in western Europe from around 14 kya cal BP.⁶¹

At present, in the absence of more robust evidence in the in-between zones (e.g., Italy), it remains difficult to make assumptions about the modalities of cultural transmission of this technological innovation between southwestern France and the Adriatic Basin. Yet, the rather sporadic presence of barbed points during the Epigravettian period of the Adriatic Basin would more likely speak of a cultural transmission of this technological novelty from a center into the Adriatic zone than of an independent local innovation or technological convergence. Furthermore, recent genomic data suggest a widespread European hunter-gatherer gene pool for individuals younger than 14 kya cal BP, i.e., from the start of the Bølling/Allerød interstadial, forming the so-called Villabruna cluster named by the oldest individual burial in the cluster from the Epigravettian site of Villabruna in northern Italy.⁶² This genomic study suggested that the population expansion at the end of the LGM might have originated in southeastern Europe and western Asia, but currently we lack good genomic coverage of Epigravettian period in the Balkans. Nevertheless, we could expect greater human mobility⁶³ around this time, and easier transfer of different cultural traits, which incorporated technological innovations. This would be consistent with the evidence at Badanj for

the introduction of several novel cultural traits starting from Level 6. Barbed points might have been an introduced part of this package of novelties.

A comparable specimen of a barbed point in the Adriatic Basin comes from the late Epigravettian Layer B/d at the site of Šandalja II in Istria.⁶⁴ Based on two existing radiocarbon measurements from this layer, this specimen is later than the dated Badanj specimens (see Table 2). Another two pointed barbed points in the wider Eastern Adriatic region have recently been found in the Epigravettian levels of the site of Vlakno on the island of Dugi Otok (Fig. 2).⁶⁵ Different morphologies found among the Badanj barbed points may point to a long period during which some of these artifacts were sporadically used, as perhaps suggested by the two new radiocarbon measurements and the stratigraphic position of currently undated specimens. Yet, the morphological variability could also point to a long period of experimentation with this novel technological solution in modifying existing patterns of predatory hunting behavior at Badanj.

As to the function of barbed points at Badanj in targeting specific prey, we could speculate that their appearance with the start of the Bølling/Allerød interstadial is not coincidental and that, similar to other cases in Europe, this could relate to the expansion of forest cover with the onset of warmer temperatures. It is also the case that at Badanj the appearance of barbed points from Level 6 onwards coincides with changes in the composition of lithic industry, which was now for the first time characterized by the appearance of geometric microliths, such as lunates and triangles (see above),⁶⁶ which were likely used as armatures for composite tools, possibly forming “lithic barbs,” perhaps with some use modifications from the earlier use of backed bladelets in a similar manner.⁶⁷ The likely homology between the use of such composite tools and antler barbed points seems unavoidable, even though the use of antler barbed points seems to have been rather restricted at Badanj compared to the abundance of flint armatures. The common assumption about the use of antler barbed points (through a harpoon operating mode) for fishing and fowling cannot be excluded even though the specimens of both taxa exhibit rather restricted frequencies in the Badanj faunal assemblage (see above⁶⁸). Other possible small prey targeted by using barbed points might have been lagomorphs (hare, rabbit), which could have some support in the steady presence of this category of prey in the composition of the faunal assemblage throughout the Badanj sequence.⁶⁹ Finally, following the suggestion that based on the evidence for the introduction of entire carcasses of red deer to the site,⁷⁰ red deer might have been hunted in the vicinity of the site, with the Bregava River possibly serving as a corridor for the transit of the herds of red deer, we may speculate that antler barbed points might have also been used for hunting this and other ungulate species trapped in water.⁷¹

Incised bone specimens

Sequential and subparallel regular incisions are noted on four examined bone objects (Fig. 15:1-3, 6). Some or all of these specimens might represent broken parts of bone tools, likely utilizing long

bone/metapodial diaphyses of a medium to large mammals. Incisions are relatively deep on three specimens and somewhat shallower incisions are found on one specimen (Fig. 15:2). They were created by a to-and-fro grooving action. Most of the incisions are relatively short notches but in one case some of the present incisions appear longer (Fig. 15:1). There does not seem to be a special preparation of the surface where these notches were made. While these objects are highly fragmented, which may prevent us from understanding the full extent of this sort of sequential incisions over the surfaces of the objects, only one set of incisions seems preserved on each tool apart from specimen 7602/1. We have tried to obtain AMS dates on two of the incised objects (10022 and 7602/1) but the samples were withdrawn due to low pretreatment collagen yield (Table 2). Yet, the stratigraphic position of all four objects can be confined to the Late period of the Badanj sequence. One of the objects comes from Level 4 and was discovered during the 1986–1987 excavations at Badanj, while the three other objects are confined either to the depths of 0.9-0.8 m (7602/1 and 7544) or 0.5-0.6 m (7806). Without having a comprehensive insight into all other such incisions on bone or stone objects at the site, one can exclude neither a practical/functional purpose of these notches, perhaps as a hafting feature if indeed these fragments were proximal parts of pointed tools, nor some sort of deliberately decorative/symbolic purpose, as is more evident in the case of other objects with more elaborate incisions (see below). Similar sequential incisions have been found on a number of bone tools (including projectile points and other less curated tools) from both early and late Epigravettian levels of Šandalja II⁷² and Vlakno⁷³. Such sequential incisions are also not uncommon on both bone and stone artifacts at a number of Epigravettian sites in Italy (e.g., Grotta Paglicci, Riparo Tagliente, Grotta Polesini, Grotta Romanelli, Grotta di Settecannelle, Grotta di Levanzo).⁷⁴

There are two bone objects from Badanj that differ from simple sequential incisions just described and exhibit more complex nonfigurative decorative patterns. Specimen 7540 (Fig. 15:4) is evenly gray-color burnt bone with old breaks. It exhibits a specific pattern of decoration, which can only be properly seen aided by a microscopic magnification (Fig. 16:2). The engraved curvilinear line was probably incised first by a burin-like tool leaving a very deep and wide groove, showing a heavily striated bottom. The curvature that the line makes is followed on both sides of the deep groove by a series of short and relatively shallow parallel to subparallel carefully executed incisions. On one, inner side of the groove where it forms an approximately 60-degree angle, the line consisting of diagonally (in relation to the main direction of the groove) placed incisions, is found immediately next to the groove. On the other, outer side of the deeply grooved line, at a short distance from the groove, three parallel curved lines are created by the same technique of placing short diagonal incisions. There is roughly equal spacing between these three lines and the deep groove.

Specimen 7541 (Fig. 15:5, Fig. 16:1) likely represents a proximal part of a broken tool made on a long bone/metapodial diaphysis of a medium-size mammal. The surface of this object was fully scraped, which might have created the unusually even beige/white coloration when compared to other bone specimens from the site. Subsequently, a multiple parallel chevron-like motif was incised on the outer surface of the shaft. The incisions are filled with a dark material, which might have been some sort of

resin. This might have been done deliberately in order to create a visual contrast between the incised dark motif and the bright whitish background. Although the surface is completely covered by consolidants, we are currently pursuing further means of identifying what was used as the filling inlay for enhancing the visibility of the engraved motif.

Both of these decorated objects found during Basler's excavation at Badanj come from the Early period in the Badanj's stratigraphic sequence judging by their respective depths of 1.2-1.3 m (inv. 7540) and 1.5-1.6 m (inv. 7541). While the sample of these two objects is obviously small for far-reaching conclusions, it could be that more elaborate decoration is confined to the early part of the Badanj sequence only. This could perhaps also be linked to the stratigraphic position of the engraved rock (see above), which was incised, according to the excavator, in the earlier parts of the sequence and covered by occupation sediments of the later Palaeolithic inhabitants of Badanj.⁷⁵

Engraving of diverse sets of decorative motifs on stone (even flint) or osseous materials, including items of adornment (see also below), is common on Epigravettian sites in the Balkans and Italy. One particular incised stone from Romanelli is similar to specimen 7541 from Badanj in the diagonal execution of parallel incisions forming a line along the incised groove. Another such motif is found on a rock from Grotta del Cavallo.⁷⁶ Chevron-like motifs have been found in Grotta del Cavallo⁷⁷ and Riparo Villabruna.⁷⁸ On an ornamented piece of bone from Grotta Paglicci, chevron-like motif was incised over the incised figurative depiction of an ibex.⁷⁹ Deeply grooved curvilinear ornamental motifs are found in Early Epigravettian levels of the site of Grotta di Settecannelle in central Italy,⁸⁰ as well as at the site of Cuina Turcului in the Danube Gorges area of the Balkans.⁸¹

Apart from patterns seen at Badanj, different incised motifs found on Epigravettian sites encompass cross-hatching patterns (Šandalja II⁸²; Riparo Tagliente⁸³; Grotta del Cavallo⁸⁴; Grotta delle Veneri⁸⁵), rectilinear double-grooved lines sometimes filled with parallel incisions or cross-hatching (Vlakno⁸⁶; Riparo Tagliente⁸⁷; Riparo Dalmeri⁸⁸; Grotta Polesini⁸⁹; Grotta di Settecannelle⁹⁰; Grotta Romanelli⁹¹; Grotta del Cavallo⁹²; Grotta delle Veneri⁹³), and zig-zag lines (Grotta del Romito⁹⁴).

Personal Ornaments

There is a large collection of items from the excavations at Badanj that most likely served as personal ornaments (over 1000 specimens from the 1976–1979 excavations alone according to the listings in the museum inventory book, of which we examined 877 specimens) comprising the following mammal body parts and mollusc species: bovid incisors (only two specimens which we will not discuss further), red deer (*Cervus elaphus*) canines, *Tritia gibbosula*, *Tritia neritea*, *Columbella rustica*, *Dentalium* sp., *Glycymeris* sp., *Pecten maximus*, *Lithoglyphus naticoides*, and *Theodoxus danubialis*. Non-edible marine and freshwater gastropods, scaphopods, and bivalves were used to create ornaments.

Red deer canines

We examined 31 specimens of red deer canines from Badanj (Fig. 17). The specimens are moderately well preserved. Most of this type of beads in the museum collection had a perforation on the root that was likely used for suspension. A lateral pattern of breakage is noticeable on a number of these holes (Fig. 17:1, 3, 14), which would suggest that these were suspended, perhaps being sewn up, on one of the narrow lateral sides. On some others, the tip of the root was broken (Fig. 17:2, 5, 9). The holes were created on the root through the preparation of this zone by scraping, which resulted in the thinning of this area in order to facilitate easier perforation (Fig. 18). One specimen was probably intentionally burnt in order to achieve a uniform black color, and a highly polished and shiny surface (Fig. 17:1). A comparable case where the argument about deliberate thermal alteration of beads was made relates to *Tritia neritea* ornaments from Upper Palaeolithic and Mesolithic levels of Franchthi cave in Greece.⁹⁵

There are two specimens that are decorated by transversal incisions over their lobe surfaces (Fig. 18). One of these specimens (7269) had transversal incisions that were very deep and were made using an unretouched flint. An analogous example of transversal incisions over the lobe of the red deer canine is known from the Epigravettian site of Riparo Tagliente.⁹⁶ As red deer canine beads were found at different depths measured from the surface, it seems that they were used throughout the sequence, appearing in both Early and Late periods of the site occupation.

Red deer canines are a relatively common type of beads on both early and late Epigravettian sites in the Adriatic Basin (e.g., Šandalja II⁹⁷; Vela Spila⁹⁸).⁹⁹ We plan a more detailed study of specimens from Badanj by applying criteria for determining age and sex of individual specimens, and in determining whether any pairs coming from both lateral sides of the same individual can be recognized.¹⁰⁰

Tritia gibbosula

We examined 25 specimens of *Tritia gibbosula* found at Badanj (Fig. 19:1-8). Beads made of this marine gastropod are overall in a poor state of preservation. Also, some specimens exhibit taphonomic alterations, such as holes created by perforating organisms (Fig. 19:3, 8, Fig. 20:3). All specimens show anthropically made perforations. It is likely that direct pressure was applied from inside to the outside in order to create these holes. Ornaments show developed traces of use indicative of their prolonged handling. Holes are all very worn and enlarged (Fig. 19:5, 7, 8, Fig. 20:2). Red ochre residues, when present, are sometimes scattered over the outside surface of the shell, which may indicate that these derive from the surrounding sediment. However, on some specimens, there are visible ochre residues along the rims, i.e., opening of the shell (Fig. 20:12), suggesting that these red ochre residues probably come from colored organic (sinew?) strings that might have been used to attach (embroider?) these

beads to an organic surface.¹⁰¹ Yet, it still remains difficult to distinguish the presence of residues from modes of suspension to residues that stick to a shell due to contact with the surrounding sediment.

Based on the depths associated with the studied specimens of *Tritia gibbosula*, all of the beads come from the Early period in the Badanj sequence. Apart from Badanj, among Epigravettian sites in the eastern Adriatic Basin catchment zone, *Tritia gibbosula* was reported to have been found at only two sites: seven specimens came from Vela Spila on the island of Korčula¹⁰² and two specimens were found in the Epigravettian levels of the site of Mališina Stijena in the deeper hinterland of Montenegro,¹⁰³ the latter dated to ca. 17–16 kya cal BP (Table 2). The absence of these beads in the late Epigravettian (after ca. 14 kya cal BP) seems to relate to a relatively confined period of their cultural popularity in this regional context but further investigation into possible environmental reasons for this absence are necessary. Moreover, considering the wider patterning of evidence for body adornment across southeastern Europe throughout the Palaeolithic and Mesolithic, it is worth noting that *Tritia gibbosula* beads are found only within the Eastern Adriatic catchment zone.¹⁰⁴

Tritia neritea

There were 326 specimens of *Tritia neritea* in the collection we were able to examine (Fig. 19:10-29). A number of specimens exhibit post-depositional alterations, such as concretions from the sediment and sometimes water-related activity that exfoliated surfaces of some beads and contributed to their poor state of preservation. Some specimens are entirely burnt while some others are partially burnt so it remains difficult to determine sometimes whether burning was deliberate, as previously suggested for a red deer canine bead (see above), or certain specimens were accidentally burnt due to the burning of the surrounding sediment in which particular beads were deposited. Judging by the evenness of burning and high polish of the surface of a number of specimens one could make a good case for deliberate burning of at least a portion of the assemblage of *Tritia neritea*, which is similar to the treatment of the same bead type at Franchthi cave in Greece.¹⁰⁵ Perforations on the shells were made by gentle pressure from the inside to the outside, i.e., from the mouth of the gastropod outside. There are well developed traces of use and rounding on most of the perforated pieces, suggesting, as with other types of beads in this assemblage, a prolonged period of their use. Preserved residues from red ochre on these beads pose similar dilemma as in the case of *Tritia gibbosula* beads, but it is clear that a number of residues relate to the modalities of suspension. For instance, there is a clear pattern of red residues on the edge of the anthropically made perforation on one of the specimens (Fig. 20:7-8). This would again suggest that likely red ochre colored organic (sinew?) strings might have been used to attach (embroider?) these beads to an organic surface. Another specimen shows a clearly visible red colored strip along the lateral side of the shell (Fig. 20:9), suggesting it was either colored intentionally or this strip was created through the contact of the shell and a colored material. Future experimental activity may better account for this particular pattern of residues.

When examining information on the depth measurements for the stratigraphic distribution of this type of beads at Badanj, they are found throughout the Badanj sequence. *Tritia neritea* beads are a widespread type of ornament throughout the Palaeolithic and Mesolithic of Mediterranean Europe.¹⁰⁶

Columbella rustica

We examined 59 specimens of *Columbella rustica* beads found in the Badanj collection (Fig. 19:30-41). These specimens are slightly better preserved than other types of ornaments. Different from *Tritia gibbosula* and *Tritia neritea* beads, perforations on *Columbella rustica* were made through indirect percussion from the outside, possibly by using a flint tool and a pebble. Traces of this procedure have left striations on the shell surface around the lower and upper part of the hole. Some of the holes are large with rounded rims of the perforation, suggesting a prolonged period of use. There are clear residue traces from affixing of the shell to an organic surface where the red ochre residues show up as a rim all around the profile of the shells (Fig. 20:4-5). A number of specimens are of evenly dark burnt coloration (Fig. 19:38-39) and, as in the case of some red deer canines and *Tritia neritea* beads (see above), these specimens might have been deliberately burnt to achieve a desirable color of the bead.

Based on the depth measurements, it seems that *Columbella rustica* are confined to the Late period in the Badanj sequence. This would correspond with other strands of data from other sites in the Adriatic Basin and Greece that suggest a shift towards popularity of *Columbella rustica* in the late phase of the Upper Palaeolithic and particularly in the Mesolithic.¹⁰⁷

Dentalium sp.

Based on the number of individual specimens, *Dentalium* sp. is the largest group in the assemblage of personal ornaments from Badanj, with 371 specimens that we have been able to examine (Fig. 19:42-55). Their overall state of preservation varies, but they are moderately well preserved. The applied consolidants over their surfaces prevent us from understanding well the way these specimens were cut, i.e., segmented. By and large, segments tend to have a standardized size of 2 to 3 cm, even though there are several very short and several longer specimens. *Dentalium* shells show rounding and beveled modifications of the rims of these segments (Fig. 20:1), which is an indication that these ornaments were used for a long period of suspension or in contact with soft organic material. Many specimens are heavily worn.

Based on the depth measurements, the majority of these beads come from the levels 1.0 m and higher, with only a handful of specimens being found at the depths of 1.4 m or 1.3-1.2 m. This would suggest that the popularity in the use of *Dentalium* sp. peaks in the Late period of occupation, which corresponds well with stratigraphic observations about the presence of these beads in the levels excavated in 1986–

1987.¹⁰⁸ Beads from *Dentalium* sp. were found in southeastern Europe since the Aurignacian period, and their popularity increases in the Late Upper Palaeolithic, but in this regional context Badanj stands out as the site with the highest frequency of *Dentalium* sp.

Glycymeris sp.

There were 53 whole or fragmented valves of *Glycymeris* sp. at Badanj (Fig. 21:1-13). Overall, the state of preservation of these specimens is poor due to taphonomic smoothing and exfoliated surfaces or occasional rounding. Thermal alteration of one of the pieces (Fig. 21:6) was probably accidental as it is of uneven coloration. Some specimens might not have been ornaments as they lack perforations, at least on the preserved part of the valve. But most of the best preserved specimens have clear perforations in the proximity of the umbone of the shell (Fig. 21:2, 4, 6, 8, 11). The holes show developed use-wear traces, thus effacing technological traces. The use-wear traces suggest that these were possibly suspended as personal ornaments.

While the majority of specimens seem to be confined to the upper part of the Badanj sequence, i.e., to the Late period, a fair number of specimens were found below 1 m of depth, i.e., down to a depth of 1.4-1.5 m, and this would suggest that this type of ornament was used throughout the Badanj sequence. One complete unperforated *Glycymeris* sp. valve and two fragmented pieces come from Epigravettian Layer VIII at Crvena Stijena in Montenegro.¹⁰⁹ Perforated specimens have been found in the late Epigravettian levels at Šandalja II (one specimen in Layer B/s), Vlakno (11 perforated specimens), and Vela Spila (five specimens) in Croatia.¹¹⁰ Perforated specimens of *Glycymeris* sp. with traces of ochre in the cavity of the shell were also found in the late Upper Palaeolithic levels at Franchthi cave in Greece (14 specimens), where, among other things, they might have had the role of pigment containers.¹¹¹ Badanj here again stands out compared to other southeastern European Upper Palaeolithic sites with by far the highest number of *Glycymeris* sp. specimens.

Pecten maximus

Only a couple of fragmentary pieces of *Pecten maximus* (Fig. 21:14-15) were found. As these specimens do not exhibit perforations, we could not be certain these were used as ornaments at Badanj. However, specimens of this type of shell bearing perforations have been documented in other parts of the Upper Palaeolithic Mediterranean.¹¹² At Badanj, these specimens seem to be confined to lower parts of the sequence.

Lithoglyphus naticoides

There were eight specimens of this freshwater gastropod at Badanj. Only four specimens had anthropically made perforations and could be considered beads. Due to the evenness of the color achieved by burning one of these specimens (7432/5, Fig. 19:9), we could suggest that it was deliberately burnt in order to create a desirable color of the bead, similar to other types of thermally altered beads in this assemblage (see above).

Theodoxus danubialis

In the museum collection, there was only one anthropically perforated specimen of freshwater gastropod *Theodoxus danubialis*.

Discussion

In hunter-gatherer studies of the Balkan Peninsula, one of the main theoretical models, proposed in the 1960s by Higgs and Vita-Finzi,¹¹³ suggested that we should expect seasonal transhumance of human groups with the pattern of winter occupation in near-coastal areas and summer habitation in the uplands and generally hinterland regions of the Adriatic. This model was in particular suggested for the sites in Epirus, Greece. In a modified version of this model for the same region, Bailey *et al.*¹¹⁴ and later Bailey and Gamble¹¹⁵ suggested Upper Palaeolithic forager population aggregations in the uplands in the summer, with sites in the hinterlands acting as specialized task locations, while winters were spent generally in the lowlands, including coastal lowlands. Others have suggested a pattern of year-round occupation of the coastal plains, such as the Adriatic Plain,¹¹⁶ while the treacherous mountainous terrain of the hinterland might have been utilized infrequently.¹¹⁷ Miracle and O'Brien¹¹⁸ criticize these models for depicting a rather static and timeless image over very long periods of time that were riddled by various forms of climatic and environmental instabilities. They also examine the usefulness of Jochim's¹¹⁹ model of environmental predictability with the resulting redundant pattern of site use, location, and seasonality, which stands in contrast to those periods of unpredictable environmental oscillations, which would have resulted in much more variable patterns of site locations, their seasonality, and aspects of use.

Taking into account the location of Badanj against the background of the proposed models for forager logistical mobility and seasonality, the prediction would, then, be that groups occupying more permanent site locations in coastal areas during the winter months might have occupied Badanj en route to more upland areas where resources aggregated during the warmer months. These stays at Badanj, according to the model prediction, thus might have occurred either in the spring or fall.¹²⁰ Also, any changes in environmental predictability in the course of the Badanj sequence, for instance the start and the end of the Bølling/Allerød interstadial, would have created deviations from the regular pattern of use, not least because of changes in the availability of territories on the North Adriatic Plain due to the sea level rise, thus spatially constraining both the distribution of animal herds and human populations.

Contrary to the model predictions, the existing seasonality indicators suggest a strong pattern of winter or late fall through to the early spring occupation of Badanj with some indicators possibly suggesting a shift in the seasonality of occupation in the later part of the sequence. While one has to be cautious with potentially unrepresentative small sample sizes for inferring fine temporal changes in seasonal scheduling at Badanj, it is clear that the site does not conform to the model for winter occupation of coastal areas and summer occupation of the hinterland. Badanj is here taken as a hinterland site despite being found in a lowland site location.¹²¹ On the other hand, while the model of environmental stability and settlement redundancy could perhaps apply to the earlier parts of the sequence, with a break in the expected redundancy of the season of occupation after Level 6, we need both a much better hold over the chronological resolution of the Badanj sequence and more robust seasonality indicators so that changes in the seasonality of occupation and the timings of various environmental shifts can properly be correlated. Despite the strong indicators of the winter occupation of Badanj, Miracle and O'Brien¹²² hesitate to rebrand Badanj as a base camp in a wider regional settlement system and conclude that the site might have been used as a special activity camp to hunt and process female red deer. At this point, apart from the focus of previous studies of Badanj on either the chipped stone industry or faunal remains as the most dominant classes of archaeological material, we believe that two categories of material culture examined in this article could potentially help in piecing together the puzzle of the site's (un)changing roles for forager groups of the region in a diachronic perspective.

Barbed points in the assemblage of osseous artifacts are of particular interest among other osseous tools as their appearance coincided with the start of the Bølling/Allerød interstadial, as shown by new AMS dates, as well as with several other changes, among which the most relevant might have been changes in the structure of lithic tools with the appearance of lunates and triangles as likely armatures for projectile points (even though this assumption needs further confirmation through dedicated use-wear studies). Such composite artifacts with "lithic barbs" might have conveyed the same idea to antler barbed projectile points in a different material. While genomic data still remain limited at present, recent analysis¹²³ suggests a widespread Villabruna cluster of genetic ancestry across Europe in the period after 14 kya cal BP, implying higher levels of mobility that might have gone in tandem with the phase of rapid warming across the continent. The tradition of Azilian osseous barbed points from the areas of southern France might have at this time reached Badanj, but it is also true that diverse cultural traits might have been transmitted in different directions. Further, the non-figural decorative patterns on some of the osseous artifacts from Badanj that we examined suggest a shared repertoire of patterns across wide areas of Italy and the Balkans at this time, further strengthening the idea of high levels of regional mobility and transfer of information.¹²⁴

On the other hand, we have already noted high frequencies and varieties of beads at Badanj when compared to other contemporaneous Epigravettian sites in the Adriatic Basin. As the excavation campaigns during which these beads were unearthed were made in the 1970s by the same excavator that previously worked at Crvena Stijena,¹²⁵ where much smaller frequencies of beads have been found in contemporaneous levels¹²⁶ over an area larger than the one investigated at Badanj, it is unlikely that

recovery bias can explain this situation.¹²⁷ Both sites are also at similar distances from the nearest coast of the Adriatic Sea with similarly rugged terrains in between. The contrast is further enhanced when Badanj is compared to coastal or near-coastal sites in the Adriatic (e.g., Vela Spila, Vlakno) where modern standards of excavation and recovery of archaeological materials with extensive programs of sieving were applied and which still produced smaller frequencies of ornamental beads. This patterning strongly suggests that although one might well predict that near-coastal locations will exhibit higher frequencies of marine species, Badanj as a hinterland location defies this prediction with a much higher percentage of different types of marine species used for ornaments than anywhere else (only Franchthi cave shows much higher frequencies of certain ornament types, but the presence of *Glycymeris* sp. at Badanj is significantly higher than at any of the extensively excavated levels at Franchthi). At the same time, these high frequencies of marine ornament types at Badanj do indicate very strong links with the coastal region, either through a pattern of logistical mobility of the groups using Badanj, that might have spent a part of the year in coastal areas where these ornaments were collected directly, or, alternatively, the ornaments might have been acquired through a network of exchanges of people and/or material culture.

Further interesting patterning regarding Badanj relates to the intra-site distribution of ornaments, where most of the material was found in the eastern-central area of the rock-shelter excavated by Basler, i.e., in the area around the engraved rock, rather than in the western zone where the 1986–1987 excavations took place. Badanj is unique in the presence of this engraved rock,¹²⁸ which is a rare occurrence of Upper Palaeolithic “art” in this regional context.¹²⁹ While we still need to obtain precise counts of all ornaments from Badanj from both phases of excavations along with more detailed analysis of spatial and vertical patterns of distribution of these ornaments, by and large we do not expect that the observed intra-site pattern will change. A hypothesis could be put forward that the higher frequency of ornaments found in Basler’s trench could in some way be linked to the presence of the engraved rock, possibly related to heightened levels of symbolic expression in this particular location within the site. We cannot exclude the possibility that the site itself, along with a range of everyday activities (hunting, processing of carcasses, hide processing, flint-knapping, armature preparation, etc.) was also a place imbued with ceremonial and ritual activities, or a place of gatherings of wider groups that shared information or held ceremonies here in the winter months, often wearing ceremonial costumes on which various ornaments might have been attached. This could further be strengthened if we take into account Kuhn and Stiner’s¹³⁰ suggestion that beads should be seen as a form of information technology for broadcasting social information to wide audiences. It seems difficult to imagine that unusually high numbers of beads for the eastern Adriatic region, with a specific intra-site spatial pattern, the presence of a rare example of parietal art, very high frequency of material culture items, and a seasonal pattern of winter occupation are all coincidental occurrences.

We would tentatively suggest that Badanj might have acted as a nexus of the maximal or regional band, a *persistent place*,¹³¹ in an extended network characterized by the assumed hexagonal packing of spatial units consisting of minimal bands as characteristic of hunter-gatherer settlement systems cross-culturally.¹³² In the light of this evidence, there should be no reason to exclude the role of Badanj as a

winter base camp, which might have had several specialized roles for the Epigravettian foragers of the wider regional zone. Future analysis of the available archaeological material from Badanj can further test this hypothesis. In addition, a better understanding of the nature of occupation at other contemporaneous sites in this micro-regional context can provide further insights into the nature of the regional forager settlement system during the Late Glacial period, providing a useful contextualization of the evidence from Badanj.

Conclusions

In this article we reviewed the existing strands of data about the Badanj sequence and presented our analyses of the previously largely unpublished assemblage of osseous tools, including newly obtained AMS dates on morphologically diagnostic curated barbed points, and the large extant collection of ornamental beads. By doing this, we attempted to re-address the relevance of this site for studies of the Upper Palaeolithic Epigravettian period in the Adriatic Basin and beyond. The unusually high frequency of personal ornaments at Badanj along with their intra-site patterning around the engraved rock suggest to us that the site might not have been used solely as a specialized hunting site for targeting pregnant female red deer herds, as proposed by previous studies, although targeting of pregnant female red deer did represent one of the important subsistence activities at Badanj. Several lines of evidence highlighted in this article suggest that we should perhaps consider Badanj as a persistent place, an important point for gatherings in the winter months, a base camp, which might have included the exchange of information and a range of ceremonial and/or ritual activities, which might have been inextricably linked to practices of hunting, over a considerable period of time. We suggest that the large amounts of different bead types found here compared to other contemporaneous sites in the Adriatic Basin and elsewhere in southeastern Europe as well as the presence of the engraved rock, and a peculiar concentration of ornaments around this rock, must all be taken into account along with other indicators of site function.

The summarized data and presented material have opened up our thinking toward further research agendas with regard to this outstanding sequence. One aspect of future research that remains of pressing importance is to provide a more robust chronological framework for the complete sequence. Further insights could also be gained through use-wear and residue analysis of stone tools, including ground stones. A better understanding of formation processes would also be possible through micromorphological and sedimentological analyses. Future work on a more fine-grained resolution of site-specific spatial and temporal patterns should be complemented by further regional surveys and excavations of chronologically overlapping sequences in this regional context. Such novel strands of data would aid previous and current efforts in putting together a more comprehensive picture of Badanj's significance for Late Upper Palaeolithic foragers as they navigated challenges brought about by changes of environmental conditions at the end of the Pleistocene.

Declarations

Competing interests: The authors declare no competing interests.

Acknowledgements

D.B. thanks Duško Šljivar for several archive photos from the 1970s excavations at Badanj. We are grateful to Karol Wehr for producing Figure 2. We acknowledge the funding for dating and study visits in Sarajevo in 2018 from ERC Starting Grant Project G.A. HIDDEN FOODS G.A. 639286 (to E.C.). This research program and related results were made possible by the support of the NOMIS Foundation in 2019 (to D.B).

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Footnotes

- 1 Alley et al. 2005.
- 2 Lambeck et al. 2002, 2004.
- 3 van Andel 1989; Bailey, Gamble 1990; Bietti 1990; Miracle 2007.
- 4 Mussi 2002, 312.
- 5 Whallon 2007a.
- 6 E.g., Miracle 1995, 1996, 2001, 2007; Mihailović 1996, 1998, 2009; Bailey 1997; Komšo, Pellegatti 2007; Farbstein et al. 2012; Karavanić et al. 2013; Cristiani et al. 2014; Vukosavljević et al. 2014; Janković et al. 2015; Šošić Klindžić et al. 2015a, 2015b; Hauck et al. 2016; Pilaar Birch, Miracle 2017; Vukosavljević, Karavanić 2017; Vukosavljević, Perhoč 2017; Whallon 2017; Vujević, Dilber 2018; Borić, Cristiani 2019; Vujević, Bodružić in press.
- 7 Basler 1976, 1979a.
- 8 Miracle, Sturdy 1991.
- 9 Basler 1976.
- 10 Basler 1976, 7.
- 11 Basler 1976, 12–13.
- 12 Basler 1976.
- 13 Basler 1979a, 1979b.
- 14 D. Šljivar, pers. communication, 2015.
- 15 Whallon 1989, 1999, 2007b.
- 16 Miracle 1995, 60.
- 17 Miracle 1995, 59.
- 18 Whallon 1989, 1999, 2007b.

- 19 Whallon 1999, 2007b.
- 20 Miracle 1995.
- 21 Miracle 1995, 128, footnote 51.
- 22 Whallon 1999.
- 23 Bronk Ramsey et al. 2002, 33.
- 24 Bronk Ramsey et al. 2017.
- 25 Basler 1979b, 349.
- 26 Whallon 1989, 9.
- 27 Whallon 1999.
- 28 Whallon 1999, 337.
- 29 Whallon 1999, Table 31.3.
- 30 Whallon 2007b.
- 31 Whallon 1999, 339.
- 32 Mercier et al. 2017.
- 33 Cf. Basler 1975.
- 34 Mihailović 2009, 87; Mihailović et al. 2017, 172.
- 35 Mihailović 2009, 78.
- 36 Whallon 1999.
- 37 Radovanović 1986; Mihailović 2009, 69.
- 38 Mihailović 1996, 1998.
- 39 Đuričić 1996.
- 40 Mihailović 2009, 93.
- 41 Bailey 1997.
- 42 Whallon 1999, 340.

- 43 Hauk et al. 2017.
- 44 Hauck et al. 2016, 2017.
- 45 Miracle 1995, 127.
- 46 Miracle 1995.
- 47 Miracle, Sturdy 1991.
- 48 Miracle 1995, 138.
- 49 Miracle 1995.
- 50 Miracle, O'Brien 1998.
- 51 Miracle, O'Brien 1998, 68.
- 52 Basler 1979b, 349.
- 53 Whallon 1999, 338.
- 54 Karavanić et al. 2013, Figs. 17–19.
- 55 Cristiani 2018.
- 56 Cf. Pétilion 2008.
- 57 Pétilion 2008, 77.
- 58 Pétilion 2008.
- 59 See Pétilion 2008, 68 and references therein.
- 60 For the evidence of recently directly AMS-dated Magdalenian barbed points see Barshay-Szmidt et al. 2016.
- 61 E.g., Julien, Orliac 2004.
- 62 Fu et al. 2016.
- 63 Including the observed Near Eastern hunter-gatherer genetic pool mixing with the European hunter-gatherers, cf. Fu et al. 2016.
- 64 Karavanić et al. 2013, Fig. 18:8.
- 65 Vujević 2018, Fig. 6.

- 66 Whallon 1999.
- 67 cf. Duches et al. 2017.
- 68 Miracle 1995.
- 69 Miracle 1995.
- 70 Miracle 1995; Miracle, O'Brien 1998.
- 71 cf. Julien 1982, 144–150.
- 72 Karavanić et al. 2013; Čujkević-Plečko, Karavanić 2018.
- 73 Vujević, Parica 2011.
- 74 Cf. Graziosi 1962; Palma di Cesnola 2004.
- 75 Basler 1979b.
- 76 Martini, Frediani 1997.
- 77 Vigliardi 1972.
- 78 Broglio 1992.
- 79 Mezzena, Palma di Cesnola 1972.
- 80 Borić, Cristiani 2016 and references therein.
- 81 Mărgărit 2008; Bonsall et al. 2016; Cârciumar, Nițu 2019.
- 82 Karavanić et al. 2013.
- 83 Leonardi 1983.
- 84 Martini, Frediani 1997.
- 85 Cremonesi 1992.
- 86 Vujević, Parica 2011.
- 87 Leonardi 1983.
- 88 Dalmeri 1998.
- 89 Radmilli 1974.

90 d'Errico, Uccelli Gnesutta 1999.

91 Acanfora 1967.

92 Martini, Frediani 1997.

93 Cremonesi 1992.

94 Graziosi 1962.

95 Perlès, Vanhaeren 2010.

96 Leonardi 1983.

97 Karavanić et al. 2013, Figs. 17, 19.

98 Cristiani et al. 2014a.

99 For syntheses of data see Cvitkušić 2017; Borić, Cristiani 2019.

100 Cf. d'Errico, Vanhaeren 2002.

101 Cf. Cristiani, Borić 2012; Cristiani et al. 2014b.

102 Cristiani et al. 2014a.

103 Bogićević, Dimitrijević 2004.

104 Borić, Cristiani 2019.

105 Perlès, Vanhaeren 2010; Perlès 2018.

106 E.g., Borić, Cristiani 2019; Perlès 2018.

107 E.g., Cristiani et al. 2014; Perlès 2018; Borić, Cristiani 2019.

108 Whallon 1999, 338.

109 Borić, Cristiani 2019, Fig. 6:1-3.

110 Cvitkušić 2017; Cvitkušić et al. 2018.

111 Perlès 2018, 65–67.

112 E.g., Álvarez-Fernández et al. 2019, Fig. 6:2.

113 Higgs, Vita-Finzi 1966.

- 114 Bailey et al. 1983.
- 115 Bailey, Gamble 1990.
- 116 Shackleton et al. 1984.
- 117 van Andel 1989.
- 118 Miracle, O'Brien 1998, 49.
- 119 Jochim 1991.
- 120 Miracle, O'Brien 1998, 49.
- 121 Miracle, O'Brien 1998, 67.
- 122 Miracle, O'Brien 1998, 67–68.
- 123 Fu et al. 2016.
- 124 Cf. Whallon 2006; Whallon et al. 2011.
- 125 See Basler 1976.
- 126 Borić, Cristiani 2019.
- 127 Đuro Basler took over excavations at Crvena Stijena in 1960–1963, during which time he expanded the extent of the excavation area in order to facilitate access to lower strata of this deeply stratified sequence. By doing this, he removed the largest part of Upper Palaeolithic levels in the rock-shelter. One should also note that from 1954 to 1958 Alojz Benac, Borivoje Čović, and Mitja Brodar directed excavations at the site, in various areas already reaching Upper Palaeolithic deposits. However, Epipalaeolithic and deeper levels were primarily reached in a rather small sondage of Trench D in the very back of the shelter, where also most of the finds were concentrated (see Vušović-Lučić et al. 2017). Hence it is unlikely that the recovery bias in this confined area of sondage D at Crvena Stijena could account for the dramatically different patterns in the frequencies of personal ornaments between Crvena Stijena and Badanj.
- 128 Basler 1976, 1979b.
- 129 But see Ruiz-Redondo et al. 2019.
- 130 Kuhn, Stiner 2007.
- 131 Cf. Schlanger 1992.
- 132 Cf. Whallon 2006, 2007a; Borić, Cristiani 2016.

Figures

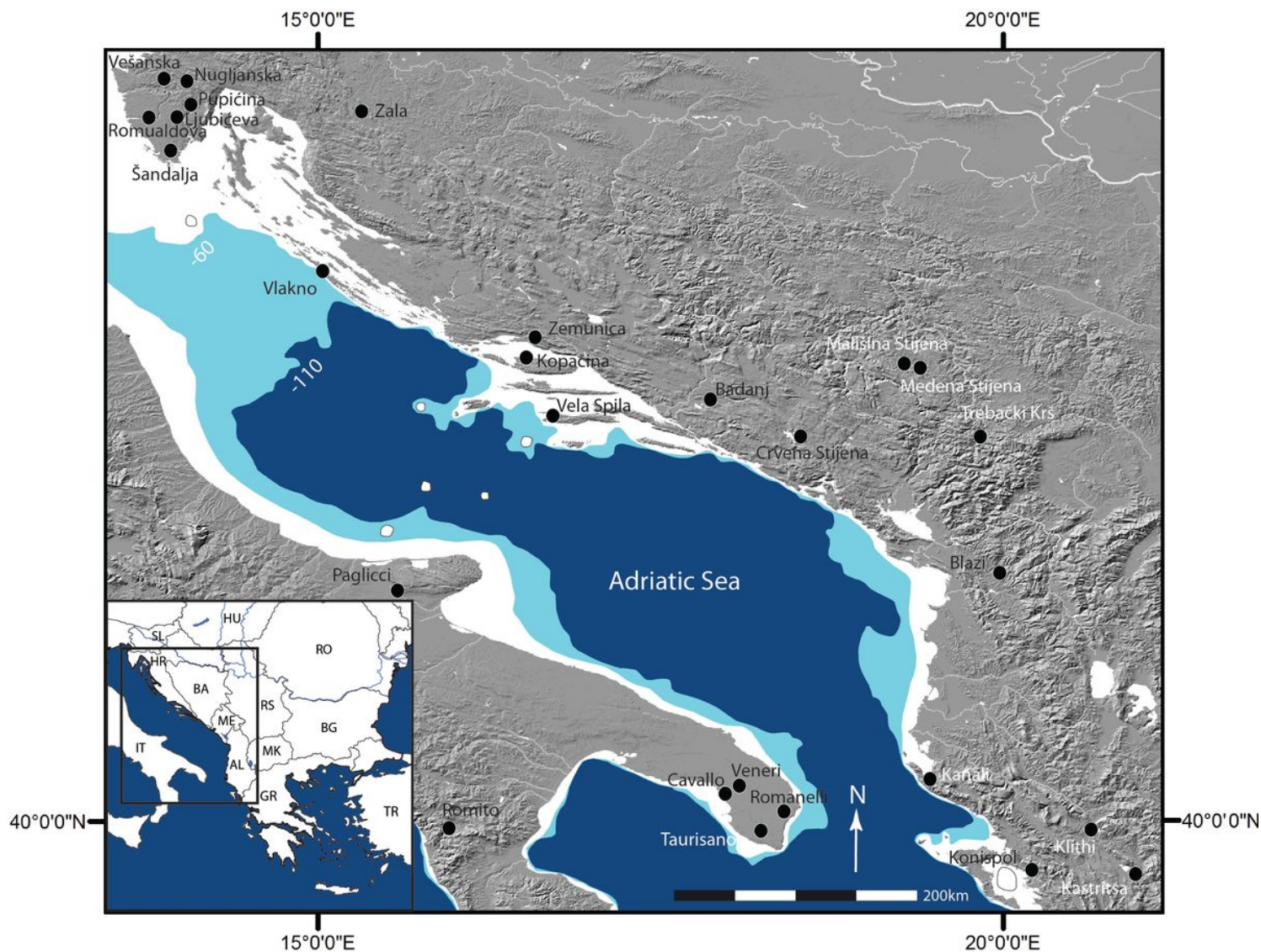


Figure 1

Map showing the distribution of Late Upper Palaeolithic sites in the Eastern Adriatic catchments zone, Epirus, and Italy. Bathymetric contours show the drop of sea levels –110 m during the LGM climax and –60 m by the end of the Pleistocene.

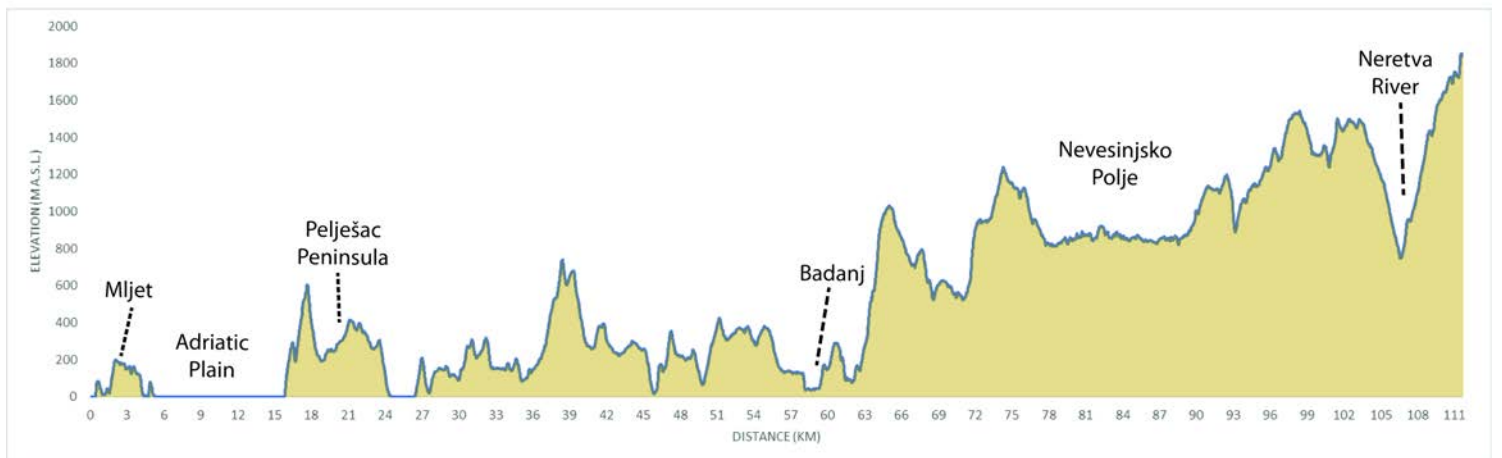
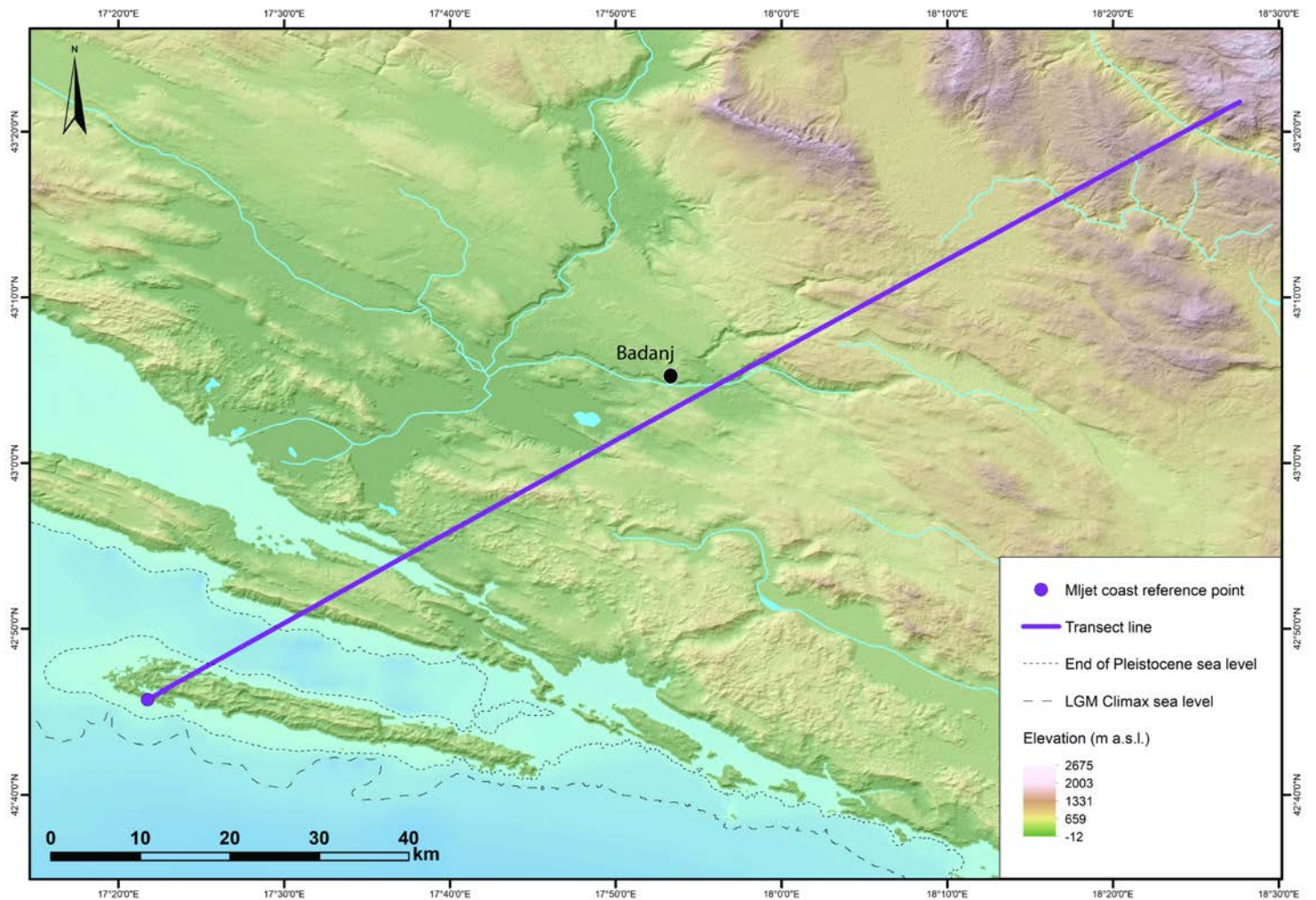


Figure 2

Close-up map showing the location of Badanj and elevation profile of topography along a SW-NE transect from the edge of the late-glacial Adriatic (off Mljet island), through Badanj, to the Dinarides (Zelena Gora). Elevation profile was created by sampling ASTER GDEM data (1 arc-second or ca. 30 metre cell size) at 15-metre intervals along the profile line in order to be certain that each cell on the profile line is sampled. Following that, coast reference point was set on the transect line and distances to it from other sampling points calculated. Sampling points were then organised by distance from the sea and

presented as a graph with distance from the sea in kilometres on the X axis and elevation in metres above sea level on the Y axis. ASTER GDEM is a product of METI and NASA. Bathymetry data provided by The European Marine Observation and Data Network (EMODnet). Figure created by Karol Wehr.



A



B



C

Figure 3

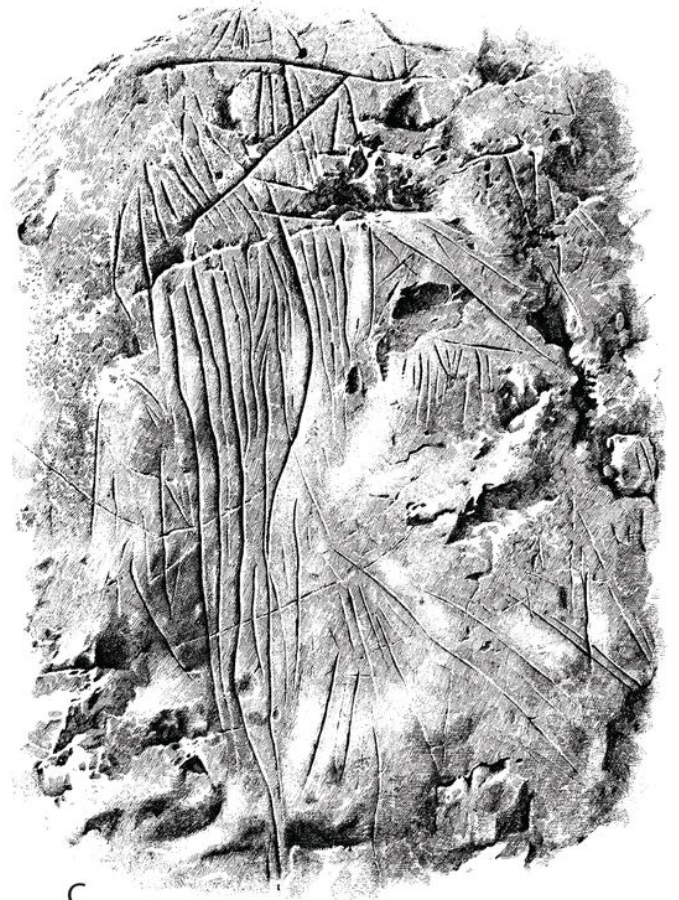
Location of Badanj rockshelter from (A) the valley floor of the Bregava River, (B) from across Bregava River, and (C) from rocks to the west of the shelter looking northeast (photos courtesy of Duško Šljivar).



A



B



C

Figure 4

(A) Location of the rock engraving boulder at Badanj; (B–C) Rock engraving (after Basler 1979b, T. XLVI).



Figure 5

Đuro Basler to the right and sieved sediment from Badanj to the left (photo courtesy of Duško Šljivar).



Figure 6

Plan of the Badanj rockshelter with excavated areas within a grid and the position of the hearth complex (adapted after Whallon 1989, Fig. 1).



Figure 7

Excavations at Badanj at the start of the 1986 field seasons.

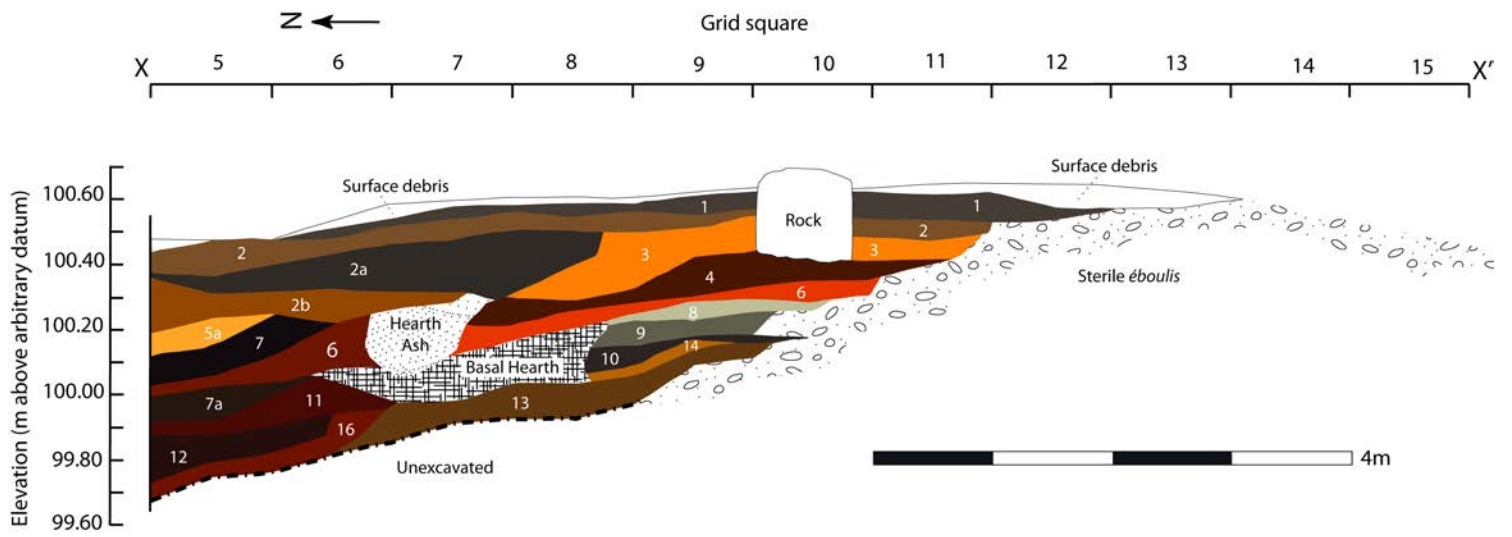


Figure 8

Representative stratigraphic north-south profile from 1986–1987 excavations along J/I line (adapted after Whallon 1999, Fig. 31.2).

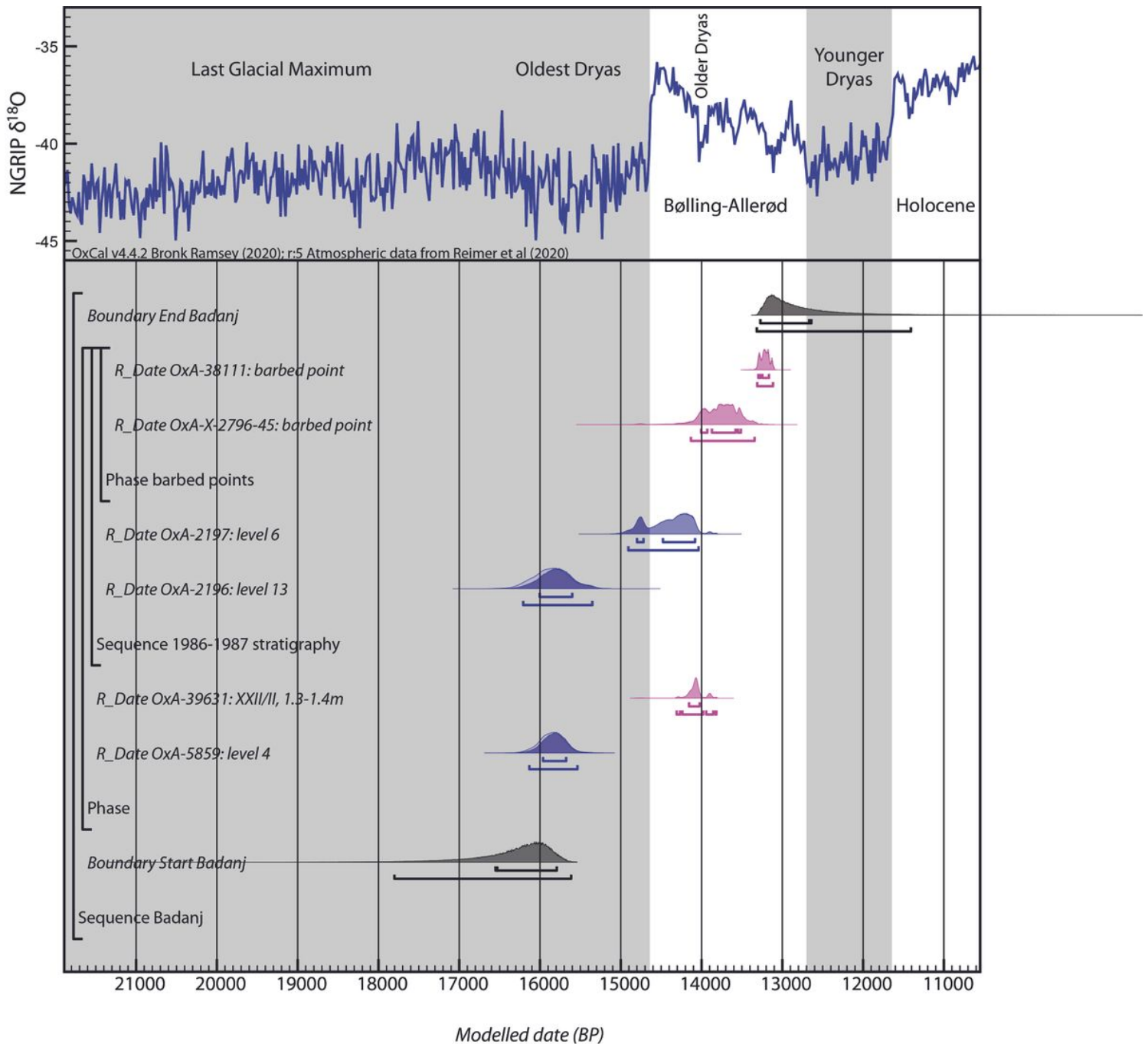
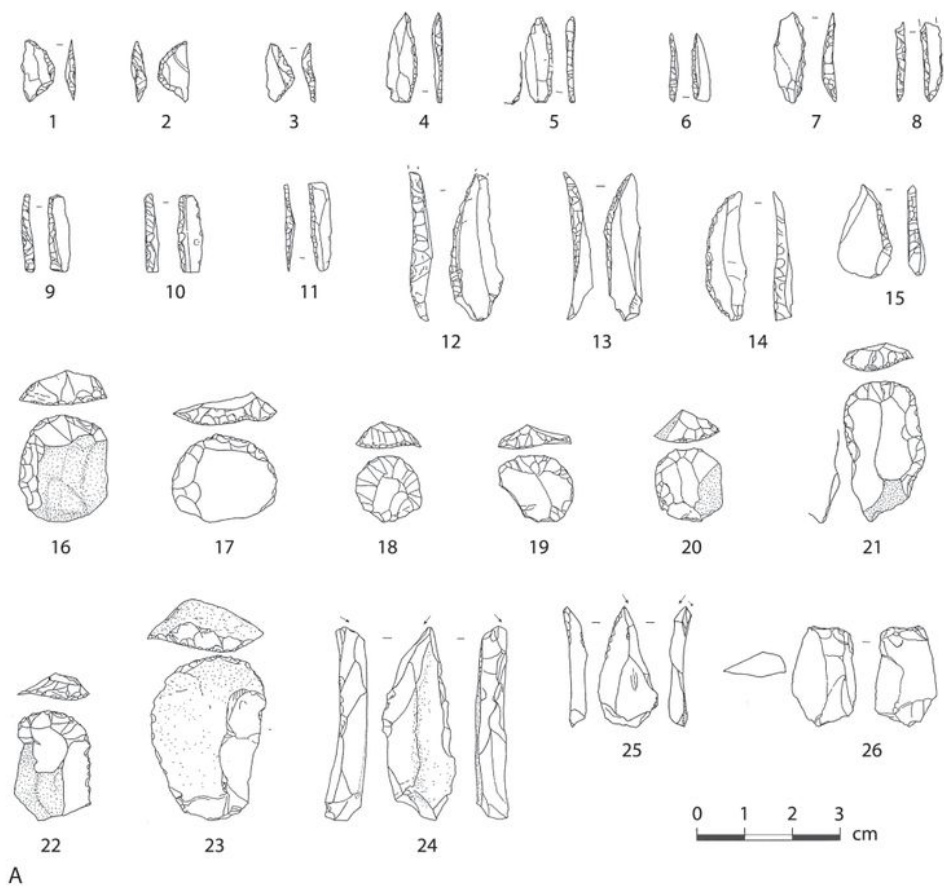


Figure 9

Bayesian modelling of all available dates from Badanj plotted against the North Greenland (NGRIP) $\delta^{18}O$ record and event stratigraphy. For the radiocarbon measurements, distributions in outline are the results of simple radiocarbon calibrations, solid distributions are the output from the chronological model. The large square brackets and OxCal v. 4.3.2 CQL2 keywords define the overall model exactly. Blue: burnt bones; magenta: red deer antler.



A



B

Figure 10

(A) A selection of flint tools discovered at Badanj (1986–1987 excavations): 1–2. Crescents; 3. Triangle; 4–11. Backed bladelets and microgavette points; 12–14. Large backed flake points; 15. Small backed flake point; 16–20. Thumb-nail flake scraper; 21–23. End-of-flake scrapers; 24–25. Burins; 26. Splintered piece (adapted after Whallon 1989, Fig. 2); (B) Massive curved retouched blade (1976–1979 excavations: inv. 7570, sq. XIV/7; T10–T20 m).



Figure 11

Pointed osseous tools from Badanj. 1. inv. 7775 (sq. XX/11, 0.3-0.4); 2. inv. 7279 (sq. XXI-XXII/15-16, surface); 3. inv. 7762 (sq. XV/7, 1.7-1.8); 4. inv. 6687 (sq. XIII/7, 0.2-0.3); 5. inv. 7763 (sq. XV/6, 0.2-0.3); 6. inv. 6695 (sq. XV/12, 1.1-1.2); 7. inv. 7774 (sq. XIX/9, 1.3-1.4); 8. inv. 7756/2 (sq. XV/5, 0.5-0.6); 9. Red deer antler blank, inv. 7808 (sq. XV/5, 1.0-1.1); 10. inv. 7259 (sq. XII/8, 1.5-1.6).



Figure 12

Barbed points made on red deer antler from Badanj: 1. inv. 10016 (sq. J5B, level 6, OxA-2796-45); 2. inv. 7063 (no context, OxA-38111); 3. inv. 10037 (sq. I7A, level 2); 4. inv. 7807 (sq. XV/6, 0.5-0.6); 5. inv. 7264 (sq. XIV/5, 0.6-0.7).



Figure 13

Close-ups of manufacturing traces on barbed points made on red deer antler from Badanj (inv. 10016 [OxA-2796-45] and 7807).



Figure 14

Close-ups of manufacturing traces on barbed points made on red deer antler from Badanj (inv. 7063 [OxA-38111] and 10037).



Figure 15

Bone tools from Badanj with sequential incisions and decorative motifs: 1. inv. 10022 (sq. K9D, level 4); 2. inv. 7602/1 (sq. XIV/6, 0.8-0.9); 3. inv. 7544 (sq. XVII/11, 0.8-0.9); 4. inv. 7540 (sq. XII/8, 1.2-1.3); 5. inv. 7541 (sq. XIII/6, 1.5-1.6); 6. inv. 7806 (sq. XV/5, 0.5-0.6).



Figure 16

Close-ups of decorative motifs on two bone artifacts. 1. inv. 7541; 2. inv. 7540.

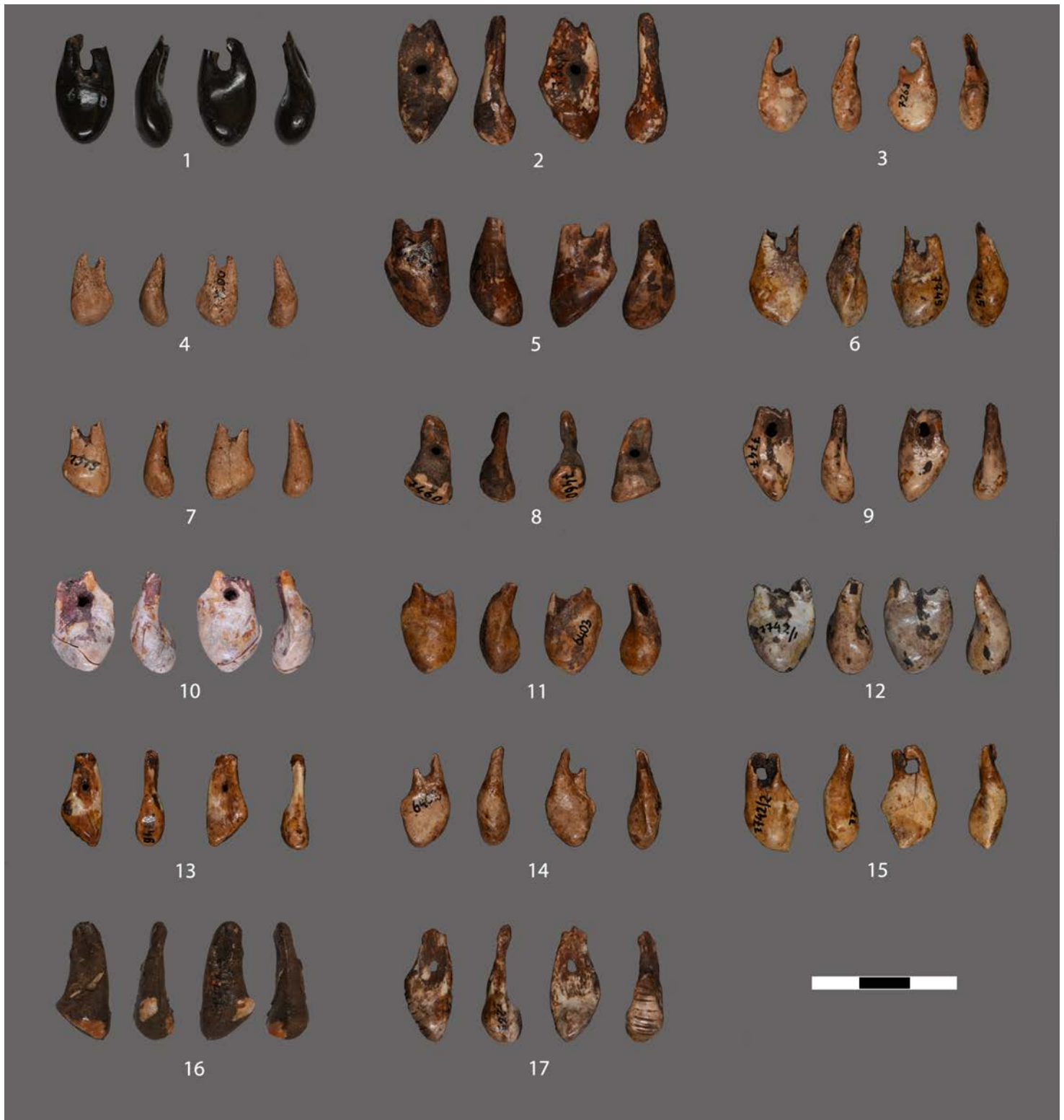


Figure 17

Red deer canines used as personal adornment from Badanj: 1. inv. 6400 (sq. XIII/8, 0.1-0.2); 2. inv. 7736/1 (sq. XV/5, 0.4-0.5); 3. inv. 7268 (sq. XVII/a, 1.5-1.6); 4. inv. 7200 (sq. XXI/14, 0.9-1.0); 5. inv. 7412 (sq. XIV/7, 0.9-1.0); 6. inv. 7745 (sq. XIX/12, 1.1-1.2); 7. inv. 7375 (sq. XIII/7, 1-1.1); 8. inv. 7460 (sq. XVII/a, 1.2-1.3); 9. inv. 7747 (sq. XIX/11, 1.4-1.5); 10. no inv. no. (sq. XV/5, 6, 7, in XIV); 11. inv. 6403 (sq. XVI/8, 0.8-0.9); 12. inv. 7742/1 (sq. XVIII/8, 1.0-1.1); 13. inv. 7746 (sq. XIX/10, 1.2-1.3); 14. inv. 6402 (sq. A, 0.2-

0.3); 15. inv. 7742/2 (sq. XVIII/8, 1-1.1); 16. inv. 7736/2 (sq. XV/5, 0.4-0.5); 17. inv. 7269 (sq. XIII/6, 1.1-1.2).



Figure 18

Close-ups of the incised red deer canine beads from Badanj: 1. inv. 7269; 2. inv. 7736/1.



Figure 19

A selection of different mollusc taxa from Badanj used as beads. *Tritia gibbosula*: 1. inv. 7384/2 (sq. XIV/6, 1.5-1.6); 2. inv. 7384/3 (sq. XIV/6, 1.5-1.6); 3. inv. 7384/4 (sq. XIV/6, 1.5-1.6); 4. inv. 7384/7 (sq. XIV/6, 1.5-1.6); 5. inv. 7733 (sq. XVIII/8, 1.5-1.6); 6. inv. 7417 (sq. XIV/8, 1.9-2.0); 7. inv. 7415 (sq. XIII/6, 1.4-1.5); 8. inv. 7687/1 (sq. XIX/12, 1.5-1.6); *Lithoglyphus naticoides*: 9. inv. 7432/5 (sq. XVII/11, 0.2-0.3); *Tritia neritea*: 10. inv. 7481 (sq. XXI/12, 0.5-0.6); 11. inv. 7703/2 (sq. XV/5, 0.0-0.1); 12. inv. 7731/2 (sq.

XVIII/9, 1.3-1.4); 13. inv. 7483/2 (sq. XXI/13, 0.6-0.7); 14. inv. 7659/4 (sq. XV/6, 0.3-0.4); 15. inv. 7383/2 (sq. XIV/6, 1.4-1.5); 16. inv. 7703/1 (sq. XV/5, 0.0-0.1); 17. inv. 7504/2 (sq. XII/10, 0.4-0.5); 18. inv. 7659/12 (sq. XV/6, 0.3-0.4); 19. inv. 7504/1 (sq. XXII/10, 0.4-0.5); 20. inv. 7735 (sq. XVIII/12, 1.5-1.6); 21. inv. 7661/8 (sq. XV/6, 0.5-0.6); 22. inv. 7659/12 (sq. XV/6, 0.3-0.4); 23. inv. 7654/5 (sq. XV/5, 0.1-0.2); 24. inv. 7660/4 (sq. XV/7, 0.3-0.4); 25. inv. 7658/1 (sq. XV/7, 0.2-0.3); 26. inv. 7656/1 (sq. XV/7, 0.0-0.2); 27. inv. 7216/1 (sq. XIV/7, 1.4-1.5); 28. inv. 7694/3 (sq. XX/12, 0.6-0.7); 29. inv. 7225/1 (no context); *Columbella rustica*: 30. inv. 7431/5 (sq. XVII/10, 0.2-0.3); 31. inv. 7431/4 (sq. XVII/10, 0.2-0.3); 32. inv. 7697/4 (sq. XX/11, 0.8-0.9); 33. inv. 7419/1 (sq. XVII/8, 0.2-0.3); 34. inv. 7600 (sq. XIV/6, 0.8-0.9); 35. inv. 7588 (sq. XVII/9, 0.1-0.2); 36. inv. 7673 (sq. XIX/11, 0.1-0.2); 37. inv. 7658/3 (sq. XV/7, 0.2-0.3); 38. inv. 7424/2 (sq. XVII/9, 0.2-0.3); 39. inv. 7210/2 (sq. XIV/7, 0.6-0.7); 40. inv. 7435/4 (sq. XVII/10, 0.4-0.5); 41. inv. 7526 (sq. XV/6-XV/7, section cleaning); *Dentalium* sp.: 42. inv. 6643 (sq. XVI/9, 0.1-0.2); 43. inv. 7036/2 (sq. XIV/6, 0.4-0.5); 44. inv. 7624/1 (sq. XIX/12, 0.5-0.6); 45. inv. 7042/6 (sq. XIII/7, 0.9-1.0); 46. inv. 7371 (sq. XIII/6, 0.4-0.5); 47. inv. 7040/8 (sq. XIV/7, 0.6-0.7); 48. inv. 7042/8 (sq. XIII/7, 0.9-1.0); 49. inv. 7449 (sq. XVII/10, 0.5-0.6); 50. inv. 7042/7 (sq. XIII/7, 0.9-1.0); 51. inv. 7035/2 (sq. XIV/5, 0.4-0.5); 52. inv. 7037/3 (sq. XIV/7, 0.4-0.5); 53. inv. 7517 (sq. XXII/11, 0.6-0.7); 54. inv. 7042/9 (sq. XIII/7, 0.9-1.0); 55. inv. 7047/1 (sq. XIV/5, 0.6-0.7).



Figure 20

Close-ups of residue traces on shells from Badanj: 1. *Dentalium* sp., inv. 7653 (sq. XIX/11, 0.5-0.6); 2–3. *Tritia gibbosula*, inv. 7687/1 (sq. XIX/12, 1.5-1.6); 4. *Columbella rustica*, inv. 7600 (sq. XIV/6, 0.8-0.9); 5. *Columbella rustica*, inv. 7431/5 (sq. XVII/10, 0.2-0.3); 6. *Tritia neritea*, inv. 7654/3 (sq. XV/5, 0.1-0.2); 7–9. *Tritia neritea*, inv. 7476/3 (sq. XXI/11, 0.4-0.5); 10–11. *Tritia neritea*, inv. 7383/2 (sq. XIV/6, 1.4-1.5); 12. *Tritia gibbosula*, inv. 7360/1 (sq. XIII/5, 1.3-1.4).

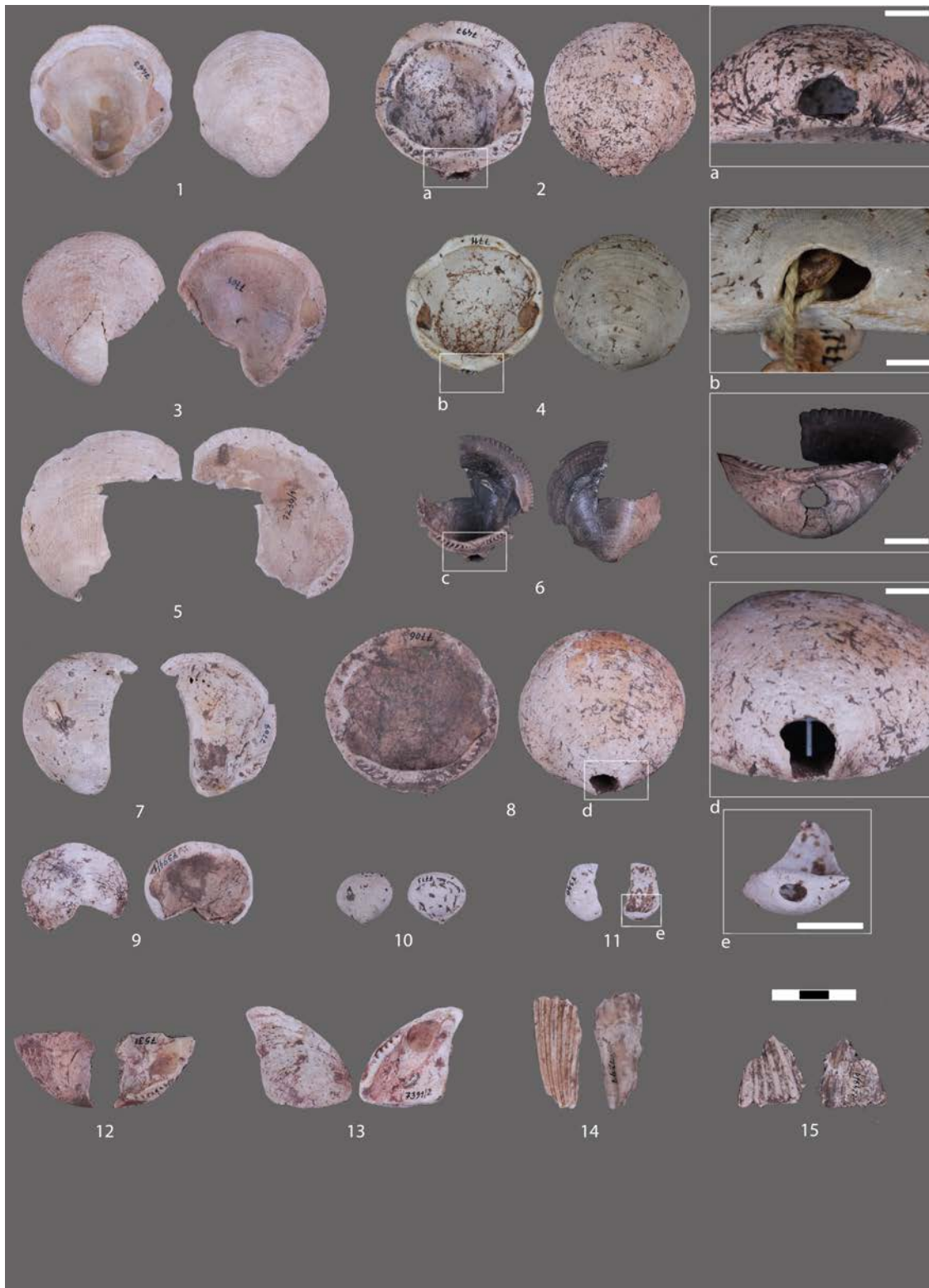


Figure 21

Personal adornment from Badanj. *Glycymeris* sp.: 1. inv. 7463 (sq. XVII/11, 0.8-0.9); 2. inv. 7497 (sq. XXI/11, 0.8-0.9); 3. inv. 7705 (sq. XV/5, 0.1-0.2); 4. inv. 7711 (sq. XV/6, 0.8-0.9); 5. inv. 7236/1 (sq. XVII/9, 1.0-1.1); 6. inv. 6676 (sq. XVI/a, 0.7-0.8); 7. inv. 7709 (sq. XV/5, 0.6-0.7); 8. inv. 7706 (sq. XV/5, 0.2-0.3); 9. inv. 7394/1 (sq. XIV/7, 0.9-1.0); 10. inv. 7713 (sq. XIX/12, 1.1-1.2); 11. inv. 7346 (sq. XIIA/8, 1.2-1.3); 12.

inv. 7391/2 (sq. XIV/6, 0.6-0.7); 13. inv. 7531 (sq. trench cleaning on 05/09/1978); Pecten maximus: 14.
inv. 7397 (sq. XIV/6, 1.6-1.7); 15. inv. 7249/1 (sq. XIII/8, 1.1-1.2).