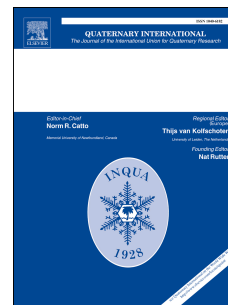


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Hunter-gatherers across the great Adriatic-Po region during the Last Glacial Maximum: Environmental and cultural dynamics

Marco Peresani, Giovanni Monegato, Cesare Ravazzi, Stefano Bertola, Davide Margaritora, Marzia Breda, Alessandro Fontana, Federica Fontana, Ivor Janković, Ivor Karavanić, Darko Komšo, Paolo Mozzi, Roberta Pini, Giulia Furlanetto, Mattia Giovanni Maria De Amicis, Zlatko Perhoč, Cosimo Posth, Livio Ronchi, Sandro Rossato, Nikola Vukosavljević, Andrea Zerboni



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1 **Title page**

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3 **Hunter-gatherers across the Great Adriatic-Po Region during the Last Glacial**
4 **Maximum: environmental and cultural dynamics**

5

6 Marco Peresani^{1,3*}, Giovanni Monegato^{2*}, Cesare Ravazzi³, Stefano Bertola¹, Davide Margaritora¹,
7 Marzia Breda^{1,4}, Alessandro Fontana⁵, Federica Fontana¹, Ivor Janković^{6,7}, Ivor Karavanić^{8,7}, Darko
8 Komšo⁹, Paolo Mozzi⁵, Roberta Pini³, Giulia Furlanetto^{3,10}, Mattia Giovanni Maria De Amicis¹⁰,
9 Zlatko Perhoč¹¹, Cosimo Posth¹², Livio Ronchi⁵, Sandro Rossato^{2,5}, Nikola Vukosavljević⁸, Andrea
10 Zerboni¹³

11

12 ¹ Università di Ferrara, Sezione di Scienze Preistoriche e Antropologiche, Dipartimento di Studi Umanistici,
13 Università di Ferrara, 44121, Ferrara, Italy

14 ² Istituto di Geoscienze e Georisorse, Consiglio Nazionale delle Ricerche, 35131, Padova, Italy

15 ³ Laboratorio di Palinologia e Paleoecologia, Istituto di Geologia Ambientale e Geoingegneria, Consiglio
16 Nazionale delle Ricerche, 20126, Milano, Italy

17 ⁴ Centro di Ateneo per i Musei, Università di Padova, 35131, Italy

18 ⁵ Dipartimento di Geoscienze, Università di Padova, 35131, Padova, Italy

19 ⁶ Institut za antropologiju, 10000, Zagreb, Croatia

20 ⁷ Department of Anthropology, University of Wyoming, Laramie, WY 82071, USA

21 ⁸ Odsjek za arheologiju, Filozofski Fakultet Sveučilišta u Zagrebu, 10000, Zagreb, Croatia

22 ⁹ Arheološki muzej Istre, 52100, Pula, Croatia

23 ¹⁰ Dipartimento di Scienze dell'ambiente e della Terra, Università di Milano Bicocca, 20126, Milano, Italy

24 ¹¹ Institut für Geowissenschaften, Ruprecht Karls Universität Heidelberg, 69117, Heidelberg, Germany

25 ¹² Forschungsbereich für Urgeschichte und Naturwissenschaftliche Archäologie

26 Archäo- und Paläogenetik, Eberhard Karls Universität Tübinge, Rümelinstraße 23, 72070 Tübingen,
27 Germany

28 ¹³ Dipartimento di Scienze della Terra "A. Desio", Università di Milano Statale, 20133, Milano, Italy

29 * Corresponding author: marco.peresani@unife.it

30 * Corresponding author: giovanni.monegato@igg.cnr.it

31

32 **Abstract**

33 During the Last Glacial Maximum (LGM, 30 to 16.5 ka ago), the Great Adriatic-Po Region
34 (GAPR) was deeply affected by the spread of glaciers from the Alps to the southern foreland and by
35 the dropping of the sea level to ~-120 m amsl. The combination of these two events triggered the
36 aggradation of the Great Po Plain (GPP), a vast flat area between the Alpine chain, the Italian
37 Peninsula and the north-western Balkan Peninsula, physically and ecologically featured through a
38 range of palaeogeographic and palaeocological conditions. The low-elevated Prealpine sectors and
39 the Alpine foothills supported more extensive forest stands, due to increased orographic rainfall.
40 These were open boreal forests which persisted throughout the LGM, while open woodlands,
41 steppes, semideserts and wetlands occupied the lowlands. A complex ecogradient, including both an
42 Alpine and a continental timberline, is documented by the fossil records at the NE Alpine border,
43 with a larch-pine forest-steppe belt, in contact with steppes and loess areas extending in the plain,
44 on the dry extreme of the gradient. Still, edaphic wetlands occupied the waterlogged silty soils in
45 the lowlands. Other areas, marked by active geodynamic processes, supported semideserts, i.e.
46 grooves of xerophytic herbs and shrubs. Enhanced aridity and the development of deflation areas,
47 prompted the accretion of loess cover at the northern and southern margins of the GPP. Fauna
48 recorded the gradual disappearance of mammoth, woolly rhino and giant deer, together with cave
49 bear. Gravettian and Epigravettian hunter-gatherer groups inhabited the GPP, although their
50 presence and settlement dynamics at the margins and across this region has long been questioned.
51 As a matter of fact, a handful of archaeological sites composes a patchy record of the peopling of
52 the plain itself. At the northern rim of the GAPR, characterized by a well-developed karst region,
53 several caves and rock shelters record the presence of hunters of bisons and horses at the margins of
54 the GPP and ibexes and cave bears in some hilly landscapes. Nonetheless, evidence of contacts
55 across this area is provided by the exploitation of chert sources and by stylistic and technical
56 similarities in the lithic industries. The work resumes the currently available multidisciplinary data
57 and adds new petroarchaeological evidence for reconstructing the settlement dynamics of the
58 Gravettian - Epigravettian hunter-gatherers in this vast region up to the early Late Glacial, when the
59 Prealpine and the Apennine foothills, along with the Dinarids, were persistently settled.

60

61 **Key words:** Environmental reconstruction; Human mobility; Upper Palaeolithic; Last Glacial
62 Maximum; Adriatic basin; Southern Europe

63

64 1. Introduction

65 Since the time of the Middle Pleistocene Revolution, the increased magnitude of glacial cycles and
66 unstable climatic conditions deeply influenced the human settlement dynamics. It is possible to
67 assume that Palaeolithic populations in Western Eurasia underwent the process defined as “Ebb and
68 Flow” (Hublin and Roebroeks, 2009), which led to their disappearance across vast areas of
69 continental Europe during the maximum extension of the ice sheets. Therefore, despite their
70 biological and cultural success with respect to the previous European “native” populations, Upper
71 Palaeolithic *Homo sapiens* hunter-gatherers experienced dramatic biological turnovers during the
72 Late Pleistocene as attested by discontinuous archaeological record (Djindjian et al., 1999, Bocquet-
73 Appel et al., 2005). The timing and pattern of multiscalar shifts that occurred from the Last Glacial
74 Maximum (hereafter LGM; 30-16.5 ka *sensu* Lambeck et al., 2014) to the onset of the Late Glacial
75 (hereafter LG) interstadial (14.7 ka cal BP) are considered to be among the most important events.
76 This period was characterized by large-scale climatic oscillations triggered by changes in insolation
77 that led to the build-up of boreal ice sheets (terminology of millennial climatic phases in the
78 following work is in accordance with Rasmussen et al., 2014). Their waxing drove sea level drop
79 and produced distinctive regional and global responses along the coasts of the North, Southwest and
80 South of Europe sea level fell to -120 m amsl (Shackleton et al., 1984) leading to the emersion of
81 major continental shelves (Fig. 1). In the Alps, glaciers were already growing before 30 ka BP
82 (Martinez-Lamas et al., 2020) and reached their maximum extent around 25.0 ± 1.7 ka cal BP
83 (Monegato et al., 2017). It is also known that forested area was very reduced in central Europe and
84 northern Europe was mostly treeless during the late MIS 3 (including GS-5) and MIS 2 (Willis et
85 al., 2000; Müller et al., 2003; Gerasimenko, 2011; Magyari et al., 2014; Rousseau et al., 2018) with
86 limited resource availability for hunters-gatherers. Nevertheless, the impact of the LGM on human
87 ecosystems has been thoughtfully investigated in Northern and Eastern Europe (Maier et al., 2016;
88 Tallavaara et al., 2015; Burke et al., 2017; Sinitsyn, 2015). Despite the ecological implications of
89 huge geographic and climate changes (Antonioli and Vai, 2004), in Southern Europe several
90 regions experienced more favourable conditions supporting the development of open boreal forests
91 and highly productive wetlands (Willis, 2000; Monegato et al., 2015; Badino et al., submitted). This
92 offered favorable environmental conditions for several mammal species (Svenning et al., 2008),
93 which could here thrive, while large part of their former distribution areal, in Central and Northern
94 Europe, was covered by ice sheets. The presence of a rich mammal fauna in these southern glacial
95 survival and refugial areas in turn gave subsistence to hunters-gatherers groups enhancing their
96 capability to maintain large-scale networks (Soffer and Gamble, 1990; Straus, 1991; Djindjian et
97 al., 1999; Roebroeks et al., 2000; Moreau, 2009). South of the Alps, these more favourable

98 conditions allowed the survival and delayed extinction of important consumers like cave bears
99 (Terlato et al., 2019a).

100 FIGURE 1 ABOUT HERE

101 Human groups reacted to the ecological turnovers by increasing their resilience, as shown by a large
102 array of evidence revealed by sites persisting at the middle latitudes. But also large migrations took
103 place through the corridors connecting the European regions, and pronounced changes in
104 demography and behaviour occurred, resulting in the synchronic and diachronic development of a
105 variety of archaeological cultures in different regions at different times (some of which remain
106 poorly understood: Djindjian et al., 1999). Lastly, this deeply contributed to the shaping of our
107 present genetic ancestry (Fu et al., 2016; Posth et al., 2016). However, a full understanding of how
108 Upper Palaeolithic groups modulated their biological, cultural and social adaptation to the Late
109 Pleistocene climate change is still far from being achieved, especially in regions of strategic
110 importance for their geographic position, geomorphological setting and biodiversity. One of these
111 corridors was the vast continental shelf that emerged as consequence of the LGM sea level low
112 stand, extending from the Western Balkan Peninsula to peninsular Italy (Maselli et al., 2014).

113

114 **Study area: geographic delimitation, subdivisions, terminology and abbreviations (see Fig. 2)**

115 Previously known as the Great Adriatic Plain, this area is indeed part of the Great Po Plain
116 (hereafter GPP), a vast alluvial landscape composed by the Po Plain (the plain of the Po River and
117 its tributaries, hereafter PP), the Venetian-Friulian Plain (the plain where present-day Venetian and
118 Friulian rivers flow not joining the Po River, hereafter VFP) and the Adriatic Plain (the plain
119 emerged during the LGM lowstand, hereafter AP) (Fig. 2). The GPP was at the centre of the Great
120 Adriatic-Po Region (hereafter GAPR), circumscribed by the northern and central Apennines, the
121 southern side of the Alps, and the Dinarides. The term Alpine (upper case) is used geographically to
122 encompass the Alps, whereas the term alpine (lower case) indicates the ecological zone above the
123 timberline ecotone (i.e. the alpine timberline, Holtmeier, 2009). Apart from the alpine timberline, a
124 continental timberline (Holtmeier, 2009) is envisaged for the LGM in the Alpine foreland. The
125 external sector of the Alps facing the GPP plains is a full mountain range but reaching lower
126 elevations compared to the internal core sector of the Alps, not exceeding the 2,200-2,300 m amsl.
127 We named such an external sector Prealpi (Prealps). It does not correspond to a foothills belt.
128 Additional terms relate the Prealps indicating specific regions (Fig. 2). In this study we focus on the
129 main part of the GAPR, bounded by the Apennine watershed, the Alpine glacier catchments and the
130 northern Adriatic coast, leaving out the central-southern belts of Italy and Croatia down to Albania.

131

132 Aims of the work

133 This area is thus supposed to have represented a paradigmatic case, thanks to its peculiar geographic
134 setting and climatic and ecological variability, which supported refugia for temperate species and
135 witnessed vast movements of populations. The human adaptive flexibility expressed by the
136 Gravettian-Epigravettian material culture, human mobility, subsistence and symbolic thinking from
137 this region has been the focus of multidisciplinary investigations. To boost our understanding of the
138 settlement dynamics, in the last decade new data were obtained from a large set of sources
139 circumscribing the GAPR, including the Italian Prealps. The present work aims to resume the
140 current state of the art regarding the paleo-geographic, ecological and anthropogenetic
141 circumstances and the evidence of the Late Pleistocene southern European population. We also
142 present additional original data issued from a new petroarchaeological investigation aimed to
143 reconstruct large-scale circulation patterns in the GAPR. These data consolidate the view that this
144 region was settled and crossed by Gravettian-Epigravettian hunter-gatherers.

145

**146 2. The geomorphological and ecological setting of the Great Po Plain and Great Adriatic-Po
147 Region during the Last Glacial Maximum**

148 The distribution pattern of terrestrial and freshwater ecosystems at the culmination of the last
149 glaciation is not a simple function of climate, but instead can be conceived as the interplay between
150 active geodynamic processes, the nature of available biodiversity, and active ecological processes
151 under the forcing of climatic conditions. In this section, we combine both physical and biotic site
152 factors to characterize ecosystems, i.e. an ecological classification system, first proposed in Italy by
153 the CLIMEX Group (Antonioli and Vai, 2004). The CLIMEX approach provided a first attempt of
154 ecozonation over the GAPR in the LGM (Ravazzi et al., 2004), which is incorporated in the updated
155 and simplified ecological zonation system shown in Tab. 1.

156 According to this system, it appears that the degree of geomorphic activity was the primary forcing
157 over the vegetation patterns during the LGM, both in the Alps and the Apennines (glacial,
158 periglacial and slope processes) and in the plains (fans and megafans aggradation). Mature steps of
159 the ecological progressions, controlled by the climate state and changes, could be achieved on
160 upland stable surfaces only and in wetlands isolated from the main drainage system (see Figs. 2 and
161 3).

162

163 2.1. Physical setting

164 For almost the whole Alps, wide portions of the Apennines and large sectors of the GPP, the LGM
165 represented a morphogenetic phase of paramount importance because of the erosion produced by
166 glacial and periglacial processes in the mountain catchments, and of the depositional phase,
167 sustained by the glaciofluvial and fluvial systems, in the plains. Thus, before the LGM the
168 landscape was dramatically different and this significantly limits the possibility to clearly
169 reconstruct the paleolandscapes existing at the onset of the LGM itself. On the other hand, the
170 surfaces and landforms related to the last phase of the LGM are still largely cropping out over major
171 portions of the GPP (Fontana et al., 2014a). Exceptions are the Apennine fringe, the Adriatic shelf
172 and the coastal plains, where the post-LGM marine transgression and the Holocene highstand
173 sedimentary processes largely reworked and/or buried them (e.g., Amorosi et al., 2008, 2016).

174 New available data for the Dalmatian coast (Brunović et al., 2020) confirm that, since the end of
175 MIS 5, the relative sea level of the Adriatic basin lowered below -50 m amsl (c.f. Antonioli et al.,
176 2009), leading to a significant increase of the alluvial plain areas in MIS 4. During MIS 3, the
177 marine level was probably between -60 and -90 m amsl (Benjamin et al., 2017), in agreement with
178 the available reconstruction for the Red Sea (Siddall et al., 2003, 2010). At that time, a complex
179 system of isolated lakes occupied part of the valleys exposed in the Kvarner Gulf and along the
180 Dalmatian coast because of the sea-level fall (Miko et al., 2016; Brunović et al., 2020). This area
181 was characterized by a karst landscape and by development of lacustrine environments, during the
182 marine lowstand (Fig. 2). Some valleys in the Prealpine hills were also occupied by lakes, as the
183 area of Fimon, in the Berici Hills (Monegato et al., 2011), and Palù di Livenza, in the Carnic
184 Prealps (cf. Bassetti and Cavulli, 1999; Peresani and Ravazzi, 2001).

185 Since MIS 4 and until the onset of the LGM, extensive swampy environments existed along the
186 present coastal sector of the Friulian Plain and in the eastern portion of the Venetian Plain (Fontana
187 et al., 2010). It is likely that in this period the PP and VFP experienced a prolonged phase of
188 morphological stability over large sectors. During MIS 4 and MIS 3 a major unresolved problem in
189 the geomorphological setting is the possible occurrence of large and deep incised fluvial valleys,
190 which could have eventually characterized the landscape of the PP and VFP, as postulated by recent
191 reviews (Fontana et al., 2014a; Amorosi et al., 2017).

192 The transition between MIS 3 and MIS 2 coincides in the southern side of the Alps with glaciers
193 spread since HS3 at 30 ka BP and followed by the glacier culmination at 25.0 ± 1.7 ka cal BP (Fig.
194 2). Glaciers maintained their front in the piedmont plain until 19 ka cal BP (Monegato et al., 2017;
195 Braakhekke et al., 2020) and, thus, the Alpine ice-field acted as a physical and environmental

196 barrier for about 10 ka, making north-south migrations of warm temperate plants, animals and even
197 of human groups unlikely. During this cold phase, the GPP lowlands were characterized by highly
198 dynamic environments with semideserts and rocky deserts; open boreal forest occupied the moister
199 areas (see section 2.2). Such climate and environmental conditions are expected to have enhanced
200 the wind strength and allowed the production, transport, and accumulation of loess deposits along
201 the margins of the whole GPP and especially on top of terraces, isolated hills, and pre-LGM
202 moraines (Cremaschi, 1987, 1990; Wacha et al., 2011a, 2011b; Cremaschi et al., 2015; Peresani and
203 Nicosia, 2015; Zerboni et al., 2015, 2018; Frigerio et al., 2017; Fontana and Ferrari, 2020; Badino
204 et al., 2020).

205 FIGURE 2 ABOUT HERE

206 Even if, in a global perspective, the onset of the LGM started already 30 ka cal BP, the fronts of the
207 major Alpine glaciers reached their first maximum advance at the outlet of the valleys only around
208 26-25 ka cal BP. This is evidenced by the up-building of terminal moraines in the southalpine
209 morainic amphitheatres (Monegato et al., 2007; 2017; Ivy-Ochs et al., 2018; Braakhekke et al.,
210 2020) and the beginning of a consistent aggradation phase of the fluvial systems fed by the southern
211 Alps (Fontana et al., 2014a; Rossato and Mozzi, 2016). The glaciers produced a strong dismantling
212 action in the mountain catchments and supported the efficient transport of the eroded sediment to
213 their fronts in the piedmont belt. Most of the major Alpine rivers acted as glacial outwashes, with a
214 significant water and solid discharge that allowed the progradation and aggradation of alluvial
215 megafans over the plain (Fontana et al., 2008). Those Alpine rivers that were not directly supplied
216 by piedmont glaciers, together with the main Apennine fluvial systems, experienced a significant
217 activity and formed large alluvial fans from their valley outlet (Castiglioni et al., 1997; Fontana et
218 al., 2014a and reference therein). In the western PP, the general tectonic framework provided high
219 accommodation space in the Savigliano basin, leading to the trapping of most of the fluvial
220 sediment yield from the south-western Alps upstream of Torino (Piana et al., 2017). Just
221 downstream of Torino, fluvial sedimentation was confined between terraces of older fluvioglacial
222 fans emanating from the Ivrea glacial amphitheatre (Giraudi, 2017). Due to this local morphological
223 constraint, the overall extent of the LGM glaciofluvial fans is, thus, significantly smaller when
224 compared with the megafans of the central PP and VFP (Fontana et al., 2014a).

225 In the proximal sector of the central PP and VFP megafans the rivers were gravelly braided, while
226 about 15-20 km downstream of the glacial fronts they were rapidly shifting to sandy braided and
227 further on to sandy wandering style, with formation of fluvial ridges along the active channels,
228 interspersed by silty and clayey floodplains. This longitudinal variation along the rivers was

229 responsible of the important differentiation in permeability and hydrographic characteristics
230 between the proximal and distal sectors of the alluvial plain along the southern side of the Alps,
231 with consequent formation of the so-called piedmont plain and low plain. Thus, we should expect
232 that a kind of spring belt already existed since the first part of the LGM (Fig. 2), generating
233 important edaphic and environmental diversity from the proximal gravelly sector, where the
234 groundwater table was at some tens of meters of depth from the surface, to the distal silty plain,
235 where the water table was close to the ground. This setting allowed the occurrence in the distal plain
236 of soils in waterlogged conditions, even over rather large areas.

237 River channels had a very high lateral mobility and avulsion was a dominant process in the fluvial
238 dynamics, so the hydrographic pattern was not stable, with frequent and rapid shifting of the river
239 paths over fan and megafan surface (Rossato and Mozzi, 2016). As documented in the distal portion
240 of the VFP megafans, the floodplain areas temporarily not affected by sedimentation could be
241 characterized by marshy environments, lasting for some decades up to several centuries, before
242 being buried by the reactivation of the overbank fluvial deposition on that portion of the plain
243 (Miola et al., 2006).

244 In the western and piedmont PP the main fluvial systems were likely merging their alluvial
245 megafans with the plain of the Po River (Fig. 2). In the northern Apennines, where small glaciers
246 were sparse and limited to the highest catchments (Losacco, 1949, 1982; Mariani et al., 2018), the
247 alluvial sedimentation partly occurred within the mountains, as documented along the major rivers
248 of Emilia-Romagna and Marche regions, where fluvial terraces dating to LGM are found between
249 15 and 60 m above the present valley floor (Picotti and Pazzaglia, 2008; Wegmann and Pazzaglia,
250 2009; Nesci et al., 2012). Alluvial fans formed from the outlets of the major valleys of the northern
251 Apennines and expanded up to 10-20 km from the mountain front (cf. Bruno et al., 2015).
252 Generally, these fluvial depositional systems were considerably smaller and thinner than the ones
253 supplied by the Alps and they have been extensively covered by the post-LGM alluvial deposition
254 in the PP (cf. Cremaschi and Nicosia, 2012). The rivers of the Marche region did not form
255 important alluvial fans in the piedmont area (Nesci et al., 2012) and they were probably incised in
256 the AP and draining into the Po River. The Po represented the trunk river of the GPP, collecting the
257 contributions of the Apennine streams and forming its delta on the shelf scarp (Amorosi et al., 2016;
258 Pellegrini et al., 2017). Nevertheless, the connections between the hydrographic network fed by
259 south-eastern Alps and the Po River are still unclear.

260 In the VFP, the megafans can be recognized for their diverging fluvial pattern and decreasing slope
261 up to about 15-20 km from the present coastline (i.e. from -20 to -30 m amsl). It is worth noting that

262 in these megafans a clear evidence of meandering channels is missing, both in the present plain and
263 in the portion submerged by the Holocene transgression, where extensive and detailed geophysical
264 surveys have been carried out (Trincardi et al., 2011). The recognized paleochannels have a rather
265 small dimension, generally not comparable even to the Holocene ones, suggesting that significant
266 part of water and sedimentary discharge was probably dispersed on the surface of the megafans.
267 Moreover, in the northern sector of the AP, the LGM fluvial network was not incised but aggrading
268 over the plain (Fontana et al., 2014a). North of the present Po River delta only a single small incised
269 fluvial valley has been documented for the LGM, 30 km offshore of Chioggia, but this belonged to
270 a minor stream not connected to a mountain catchment (Ronchi et al., 2018).

271 These data allow hypothesizing that, during significant periods of the LGM, the hydrography of NE
272 Italy was not merging together in a single large river and, eventually, not reaching the Po River.

273 A rather different situation characterized the eastern side of the AP, along Istria and Dalmatia,
274 where most of the rivers had a limited water and sedimentary discharge because of their karst
275 catchments (Pikelj and Juračić, 2013; Felja et al., 2015; Furlani et al., 2016, Novak et al., 2020).
276 Small ice-caps developed in the highest mountains but outwash fans were confined to polje areas
277 (Žebre and Stepišnik, 2015; Žebre et al., 2016; Sarıkaya et al., 2020). It is likely that the related
278 fluvial network was incised in the AP but, for a complete reconstruction of the LGM
279 palaeogeography, a major obstacle is represented by the lack of information from the offshore
280 sector of Croatia.

281 The idea of an AP with a well-formed and interconnected hydrographic network, as proposed in the
282 first reconstruction by De Marchi (1922) and also described in recent papers (e.g. Amorosi et al.,
283 2016), is hardly applicable to the unstable fluvial systems characterizing the LGM.
284 Notwithstanding, the role of the Po River as the main fluvial system collecting most of the sediment
285 produced in the GAPR during the LGM is well testified by the formation of its delta in the Mid
286 Adriatic Depression. Between 31.8 and 14.4 ka cal BP the delta aggraded for about 350 m of
287 thickness over the scarp of the continental shelf but, because of the steep slope of the scarp, the
288 coastline shifting was rather limited, in the range of about 30 km during the LGM (cf. Pellegrini et
289 al., 2017, 2018).

290 Approximately between 24 and 23 ka cal BP the glaciers of the southern Alps experienced a limited
291 recessional phase, which led them to temporarily withdraw for some kilometers from the most
292 external moraines, as shown in the Tagliamento and Garda end-moraine systems (Monegato et al.,
293 2007, 2017). This setting induced also a reduction in the fluvial activity over fans and megafans
294 (Rossato and Mozzi, 2016; Hippe et al., 2018). The recession phase broadly encompasses the so-

295 called Greenland Interstadial 2 (GI2), a phase of important cultural turnover among hunters-
296 gatherers societies of Europe (Djindjian et al., 1999; Ducasse, 2012).

297 A second peak of glacial advance occurred between 23 and 22 ka cal BP (Monegato et al., 2017),
298 leading to a renewed expansion of the glacial fronts in the piedmont area. During this phase, the
299 fluvial activity had the same characteristics described above for the first LGM glacial expansion
300 (i.e. 27-25 ka cal BP).

301 Since about 22 ka cal BP, the Garda glacier started its recessional phase, anyhow it occupied part of
302 the morainic amphitheatre until 17.7 ka cal BP, when it collapsed (Ravazzi et al., 2014; Monegato
303 et al., 2017). A similar chronology is suggested for the Tagliamento end-moraine system, where the
304 glacier abandoned the plain already 19.0 ka cal BP (Fontana et al., 2014b). The same time intervals
305 are documented also for the last activity of the alluvial megafans of the VFP, where the Brenta
306 megafan was the last one to switch from aggradation to incision at around 17.5 ka cal BP (Rossato
307 and Mozzi, 2016).

308 Between 18 and 17.5 ka cal BP, the glaciers were collapsing (Wirsig et al., 2016) and they rapidly
309 withdrew towards the upland catchments, leading to dramatic changes both in the Alpine valleys
310 and in the alluvial plains. Between 22 and 17.5 ka cal BP part of the fans and megafans did already
311 experience an erosive phase, which led the active channel to entrench in their apical portion. The
312 northern sector of PP experienced the entrenchment of the Alpine rivers up to their junction with the
313 Po River (Marchetti, 2001). The VFP major incised valleys formed in the alluvial megafans of the
314 Tagliamento and Piave Rivers (Carton et al., 2009; Fontana et al., 2014a) between 19 and 15 ka cal
315 BP, while in the Brenta megafan they started after 17.5 ka cal BP (Mozzi et al., 2013). Thus,
316 between 19 and 16 ka cal BP, the GAPR experienced a dramatic change in the geomorphic
317 processes, especially in the Alpine sector, where the glacial withdrawal allowed the progressive
318 opening of valley corridors, while in the northern PP and VFP large surfaces became stable. Since
319 about 16.5 ka cal BP also the rapid sea-level rise begun (Lambeck et al., 2014), but the position of
320 the Adriatic coastline started to change considerably only after 15 ka cal BP, when the sea stepped
321 over the edge of the continental scarp and could transgress over the AP.

322 During the LG, a short cooling occurred at about 16.4-16.2 ka cal BP, which is marked by the
323 Ragona oscillation (Monegato et al., 2007; Ravazzi et al., 2012; Schmidt et al., 2012). This may be
324 correlated to a short glacier readvance, known as Gschnitz stadial, which is documented from the
325 Maritime Alps (Federici et al., 2017) to the Central Alps (Ivy-Ochs et al., 2009; Ghinoi and Soldati,
326 2017).

327

328 **2.2. Ecozones of the Great Adriatic-Po Region in the Last Glacial Maximum, their vegetation** 329 **and climatic patterns**

330 In this section, we combine both physical and biotic site factors to characterize ecosystems, i.e. an
331 ecological classification system, first proposed in Italy by the CLIMEX Group (Antonioli and Vai,
332 2004). The CLIMEX approach provided a first attempt of ecozonation over the GAPR in the LGM
333 (Ravazzi et al., 2004), which is incorporated in the updated and simplified ecological zonation
334 system shown in Tab. 1.

335 According to this system, it appears that the degree of geomorphic activity was the primary forcing
336 over the vegetation patterns during the LGM, both in the Alps and the Apennines (glacial,
337 periglacial and slope processes) and in the plains (fans and megafans aggradation). Mature steps of
338 the ecological progressions, controlled by the climate state and changes, could be achieved on
339 upland stable surfaces only and in wetlands isolated from the main drainage system (see Figs. 2 and
340 3).

341

342 **The vegetation of the plain ecozones.** Active megafans were pioneered by edaphic semideserts,
343 dominated by xerophytic herbs and shrubs (*Artemisia*, *Hippophäe*, *Juniperus*, *Ephedra*, *Berberis*)
344 on bars and abandoned riverbeds, especially on coarse (gravelly) sediments (see Tab. 1 and Fig. 3
345 for fossil sites documenting this ecozone; see Fig. 4 for a modern analogue). Downstream, these
346 semideserts probably connected with climatic semideserts and deserts (annual rainfall below 300
347 mm; see Badino et al., submitted) that developed in the depressed Adriatic plain. Here we also
348 envisage riverside vegetation relevant both for the mammal fauna and the humans, but the
349 palaeoecological documentation is scarce (Tab. 1). Extensive wetlands developed in the lower
350 megafan belts, in the water-saturated silty soils in the lowland areas, especially in the VFP (Miola et
351 al., 2003; Serandrei Barbero et al., 2005). A birch swamp has been recently described in the lower
352 Adda megafan (Ravazzi et al., 2018, 2020).

353 TABLE 1, FIGURES 3 AND 4 ABOUT HERE

354 **The forest ecozone and its double timberline ecogradient. The continental timberline and the**
355 **elevational timberline.** The concept of double timberline, elaborated in the modern analogues of
356 the high mountain ranges emerging from semiarid steppe of Asia and North-America (Walter and
357 Breckle, 1986; Chytrý et al., 2008; Holtmeier, 2009) may apply to the southern border of the Alps
358 and their foothills during late MIS 3-MIS 2 and it is visualized in the sketch of Fig. 4. The fossil

359 sites of Azzano Decimo, Renče and Fimon (Pini et al., 2009; Monegato et al., 2015; Badino et al.,
360 submitted) document the continental boundary of the forested region at the NE Alpine border (Fig.
361 3). The modern pollen analogues lie in the forest-steppe ecogradient in the Altaj mountains at the
362 Russian-Mongolian border (Chytrý et al., 2008; Magyari et al., 2014; Badino et al., submitted), with
363 a larch-pine forest-steppe belt at the continental timberline limit (300 mm annual rainfall and boreal
364 continental climate; Zhambazhamts and Bat, 1985; Makunina, 2016), in contact with steppes and
365 loess areas on the dry extreme of the gradient. The structure and position of the elevational
366 timberline in the LGM is hardly documented by fossil elevational sites, so far available for the early
367 Late Glacial only (Vescovi et al., 2007; Ravazzi et al., 2012). Based on modern Asian pollen
368 analogues, an ecoclimatic elevational model based on temperature lapse rate (Gorbunov, 1978;
369 Matthews, 1992) allowed estimating the elevation of the Alpine timberline at around 700 m in the
370 NE Prealps (Ravazzi et al., 2004). It is envisaged that *Pinus mugo* dwarf forests played an important
371 role at timberline elevations on areas characterized by carbonate bedrock in the Eastern Prealps
372 (Ravazzi and Vescovi, 2009), especially on south-facing slopes with periglacial activity. According
373 to ecological analogues, and to palaeoglaciological and climate modelling (Barron and Pollard,
374 2002; Luetscher et al., 2015; Becker et al., 2016), the forest ecozone experienced orographic
375 precipitation due to the windward forced advection of southern airmasses. Simulations of winter
376 snowfall at the southern Alpine fringe provide a net increment of winter snow height moving from
377 MIS 3 stadials (Berici Hills = 10 cm winter snow height) to an advanced phase of the LGM, 21 ka
378 cal BP (Berici Hills = 138 cm winter snow height) (see Barron and Pollard, 2002; Pini et al. 2010,
379 their tab. 4).

380 **The alpine vegetation ecozones.** A wide ecotone of alpine grasslands, steppe-grasslands and
381 petrophytic semideserts is predicted to have withstood the LGM on stable unglaciated areas beyond
382 the elevational timberline (Tab. 1). Unfortunately, this figure is still poorly documented by fossil
383 sites and only at low elevation (Fig. 3; Ravazzi et al., 2012). This ecozone supported rich
384 populations of ungulates and preserves hotspots of endemic herbs and invertebrate herbivore
385 communities. The biodiversity in this ecozone experienced great success downhill of its interglacial
386 range, following late MIS 3 forest withdrawal (e.g. Pini et al., 2010). The alpine ecozone is
387 predicted to have expanded downhill over the sunny slopes. Still, these communities were able to
388 settle areas over the valley glaciers (Antonioli and Vai, 2004). The range of many species shifted
389 down, prompting vehiculation by wind, organisms, runoff, waterscapes, or by the glaciers
390 themselves (Pelfini et al., 2012) towards adjacent regions that acted as survival or refugial areas,
391 and back at the Late Glacial climate reversal. Consequently, the LGM refugial areas of mobile
392 species mismatched the modern range of modern biodiversity hotspots, a fact readily overlooked by

393 fenetic biogeography and by phylogeography in the Alps (Merxmüller, 1952, 1953, 1954;
394 Schönswetter et al., 2005). Indeed, and contrary to recent statements (Cheddadi and Bennett, 2020),
395 yet there is no fossil record supporting the location of LGM microrefugia in the Prealps based on
396 modern ecogeography. For other elevational ecozones see Tab. 1.

397

398 **2.3. Zoogeographic setting**

399 The distribution of the continental fauna in the GAPR has a transitional character, given the position
400 of this area between two zoogeographic regions, south-western and central-eastern Europe. During
401 the Middle and Late Pleistocene, continental and peninsular Italy was divided into a temperate
402 Ligurian-Tyrrhenian-Ionic bioprovince and a Padano-Adriatic bioprovince with fauna of harsher
403 climatic conditions, in particular during the LGM (Sala, 2004). The path in central Slovenia served
404 as a passage from the Pannonian basin and the Balkans for many mammals. This was the case for
405 large pachyderms as the mammoth (*Mammuthus primigenius*), and woolly rhino (*Coelodonta*
406 *antiquitatis*), and large ruminants as the giant deer (*Megaloceros giganteus*), the moose (*Alces*
407 *alces*), and the steppe bison (*Bison priscus*). Apart from the woolly rhino, which entered Italy only
408 during the Last Glaciation, the other large ungulates had already reached the Po Plain through the
409 northern Adriatic route during the previous glaciation (MIS 6 - Sala and Marchetti, 2006) together
410 with the alpine ibex (*Capra ibex*), the chamois (*Rupicapra rupicapra*), and the marmot (*Marmota*
411 *marmota*). However, during the last interglacial warm phase, ibex, chamois and marmot retired to
412 higher elevation to find their climatic optimum. This was due to the particular geographic situation
413 of Italy, closed at the north by the Alpine chain which created a barrier to the latitudinal migration
414 of megafaunas which otherwise interested most of Europe, during the glacial-interglacial episodes
415 of the Middle and Late Pleistocene. Thus, while the warm stages were trapping into the Italian
416 Peninsula cold adapted species, leading to their altitudinal shift or local demise, cold episodes
417 opened the northern AP as an easy access route from the Pannonian Basin and the Balkans through
418 central Slovenia.

419 During the last glacial period (Monegato and Ravazzi, 2018), this same route into Italy was
420 followed also by several cold-adapted rodents and lagomorphs now retired in north-eastern Europe
421 or central Asia, such as the tundra vole (*Microtus oeconomus*), the northern birch mouse (*Sicista*
422 *betulina*), the European hamster (*Cricetus cricetus*) and the steppe pika (*Ochotona pusilla*). These
423 have been recorded from different layers of Riparo Tagliente (n°30 in Fig. 3 - Berto et al., 2018)
424 and Fumane Cave (n°29 in Fig. 3 - López-García et al., 2015). Some of these small mammals
425 colonised only the Po Plain and the lower hills of the Prealpine and pre-Apennine zones, as, among

426 large ungulates, the cold-adapted moose, which never crossed the Apennine barrier to reach the
427 Tyrrhenian side of Italy (Breda, 2002) and which retired in north-eastern Europe as well. This
428 distribution of some elements of the fauna, supports the idea of the existence of two distinct
429 bioprovinces (Sala and Marchetti, 2006). On the contrary, animals such as mammoth, wholly rhino,
430 giant deer and bison dispersed through the entire peninsula, reaching the Tyrrhenian side but also as
431 far south as the Salento (Puglia region, Petronio et al., 1996). However, during the LGM, further
432 immigration from the nearby Pannonian basin did not take place probably because the north-east
433 passage through Slovenia was inaccessible due to the high snow cover (Sala, 2004). So, when
434 mammoth, woolly rhino and giant deer gradually disappeared from Italy between 33 and 24 ka,
435 together with pre-existing elements, such as the fallow deer (*Dama dama*), the leopard (*Panthera*
436 *pardus*), the cave bear (*Ursus spelaeus*), and the hyena (*Crocuta crocuta*), toward the end of the
437 LGM, they left a much-impooverished fauna (Sala 2007). Particularly, the radiocarbon dating of cave
438 bear remains from the Berici Hills in the subalpine area (n°11 in Fig. 3), to 24.2 – 23.5 ka cal BP,
439 makes them the latest known record of this species in Europe (Terlato et al., 2019a). The latter
440 evidence testifies that the Berici Hills – thanks to the availability of trophic resources and caves –
441 were the last refugium for the large plantigrade in Europe. Despite the long trend of negative human
442 and climate effects, increased at around 30 ka cal BP, had fragmented the cave bear population into
443 various subpopulations inhabiting small refugial habitats, the broad range of plant types available
444 along the meltwater rivers and wetlands at the edge of the VFP and favourable winter temperatures
445 on low elevation karstic hills allowed their survival here for few additional thousand years. Isotopic
446 values from the bones suggest that the dietary preferences of cave bears remained unchanged until
447 their disappearance (Terlato et al., 2019a) and that interaction with the Palaeolithic hunters, who
448 settled the same district, were (probably) the forcing factors leading to their final extinction. A
449 similar trend could be envisaged also for *Ursus ingressus*, an intrusive species in this region and
450 representative of the genetically impooverished relict of a larger East European population, as
451 revealed from the sequencing of mitochondrial DNA (Gretzinger et al., 2019).

452 Thus, during the LGM and up to the LG interstadial, the iconic herbivorous species in the plain and
453 in the lower hilly landscapes of the Apennines was the steppe bison (*B. priscus*). Remains have
454 been found in the Karst, at Grotta Tilde (Trieste – n°26 in Fig. 3), associated with horse (Riedel,
455 1980), at Manerba in the glacial amphitheatre surrounding the Garda lake (n°12 in Fig. 3 - Ravazzi
456 et al., 2014), at Settepolesini quarry at the centre of the Po Plain (n°25 in Fig. 3 - Sala, 2001), at
457 Cava a Filo quarry at 225 m of elevation in the northern slope of the Apennine (n°27 in Fig. 3), and
458 in minor sites scattered at several locations in the rim of the GAPR (Fig. 3). The Cava a Filo faunal
459 assemblages, dated between 24.5 and 17.5 ka cal BP (Paronuzzi et al., 2018a), are dominated by

460 bison in association with *Canis lupus* and *Capreolus capreolus* in an environment with poorly
461 differentiated fauna. Three chronological intervals have been recognised through radiocarbon
462 dating, representing two cold intervals of the LGM and the beginning of the LG (Paronuzzi et al.,
463 2018a). *Megaloceros giganteus* appears in the Cava a Filo 1 association with *Meles meles*, *Lepus*
464 *timidus* and *Marmota marmota*, which in Cava a Filo 2 association, are joined by *Vulpes vulpes*.
465 Cava a Filo 3 dates to 18.6-17.4 ka cal BP and records an increased diversity with *Sus scrofa* and
466 *Mustela erminea*, in addition to the large mammals already present in the older levels, consistent
467 with a more forested environment and with the climatic amelioration of the beginning of the LG
468 (Paronuzzi et al., 2018a). Roughly correlated with the Cava a Filo 3 fauna, but recording a drier
469 environment, are the Late Glacial levels of Settepolesini (n°25 in Fig. 3) where *Bison priscus*
470 persists beyond 16.4 ka cal BP in virtue of its reduced nutritional requirements that allowed it to
471 thrive also in arid steppes where more demanding herbivores could not survive (Sala and Gallini,
472 2002).

473 In the foothills and subalpine area of southeastern Alps, the ibex is the most common species during
474 the LGM. The deer and the roe deer are very rare like the Equidae (Bartolomei et al., 1977). As
475 noted by Sala (2007), in the sites dated to the earliest LG period on the Berici hills and at the foot of
476 the Venetian Prealps, the ibex is still very abundant, together with the chamois where steep slopes
477 are present (e.g. lower levels of Riparo Tagliente; n°30 in Fig. 3 - Fontana et al., 2009).

478 Archaeofaunas from cave deposits also record the presence of carnivores like *Vulpes vulpes*, *Felis*
479 *silvestris* and *Canis lupus* in addition to the cave bear (Romandini and Nannini, 2012). The moose
480 is recorded and relatively abundant both in the plains along with the bison (e.g. Settepolesini).

481 Bison also reached the moraine amphitheatres (e.g. Manerba; Ravazzi et al., 2014) and low Prealps
482 (e.g. Riparo Tagliente, Grotta Paina, Grotta Trene and Grotta Tilde) because, moving along riparian
483 habitats, it can span a wide variety of environments and climates (Breda, 2001; 2002). Conifer or
484 mixed open forests with grasslands, slow-flowing water bodies and mountain meadows with rocky
485 outcrops are the habitat predicted by bird assemblages from sites in the Carnic Prealps (Grotta
486 Rio Secco: n°31 in Fig. 3 - Carrera et al., 2018a) and the Berici Hills (Buso Doppio Broion: n°6 in
487 Fig. 3 - Carrera et al., 2018b) alongside with sparse cyprinid and salmonid remains (Romandini et
488 al., 2015). Furthermore, the presence at the onset of LGM of *Bubo scandiacus* and *Surnia ulula*,
489 two cold-adapted species currently distributed at high latitude in the Boreal hemisphere, is a clear
490 marker of cold ecozones with herb and low shrub vegetation and of boreal forest (Carrera et al.,
491 2018b). Still on the Adriatic side, as well as in Apulia, the most widespread species is the ibex,
492 along with the horse, and frequently *Equus hydruntinus* as well. In the southern sector of the GAPR
493 (not included in this work), the bison is replaced by the aurochs, which are numerous there, while

494 red deer and wild boar are rare (Sala, 2004). The horse (*Equus ferus*; *Equus hydruntinus*) is also
495 part of the faunal assemblages in Istria along with auroch, ibex, red deer and roe deer (Janković et
496 al., 2017; Mauch-Lenardić et al., 2018; Weinstock, 2017). Marmot and hare are recorded with
497 variable incidence across the whole GAPP.

498

499 **3. Hunter-gatherers around the Great Adriatic-Po Region**

500 The GAPP is suggested to have played a major role in promoting large-scale migratory fluxes, a
501 phenomenon also hypothesised for much older periods across the whole Pleistocene (Palombo and
502 Mussi, 2006; Muttoni et al., 2010). Due to its geographic position and ecological variability, this
503 area can provide evidence for reconstructing the evolution of the present-day amph-Adriatic
504 biogeographical connections displayed by several floral and invertebrate taxa (Frajman and
505 Schönewetter, 2017), together with human settling and exploitation of mountain refugial habitats
506 at both sides of the GPP during the LGM (Peresani, 2019) (Fig. 3).

507

508 **3.1. Cultural background**

509 Given its geographic position at the interface between two main domains regions of southern
510 Europe, the GPP represented a crossing-area along the route of human groups starting from around
511 the Danube basin to the Mediterranean regions (Montet-White, 1996). Evidence of this is the spread
512 of the Gravettian and Epigravettian cultures, which are recorded with detail up to the southern
513 Adriatic coast (Palma di Cesnola, 2004). Gravettian-Epigravettian societies adapted in response to
514 environment, resources and exploitation strategies; technical hunting behaviour turns out to be a key
515 element in the identification of these phenomena (Wierer, 2013). Backed tools are the most
516 diagnostic trait of the Gravettian and their typological features were used for its tripartite
517 subdivision into early, middle (evolved) and late (final), being the first phase characterized both by
518 invasive backed points and the occurrence of marginally backed points. Among these latter, the
519 specific type *fléchette*, a leaf-shaped point characterized by marginal semi-abrupt retouch
520 sometimes inverse at one or both ends of the blade blank, is rather typical for the early Gravettian as
521 confirmed at Grotta Paglicci, layer 22 (Palma di Cesnola, 2004). This technocultural facies (also
522 known as “Undifferentiated” or “Gravettian with backed points”; Palma di Cesnola, 2006) is
523 present in the whole Italian Peninsula (Palma di Cesnola, 1993; Gambassini, 2007). The Gravettian
524 is also typified from the invasive *Gravette*-type backed points and the Vachon points (Simonet,
525 2011). End-scrapers are also a basic component of the common domestic Gravettian tool-sets, in

526 addition to scrapers made on flake and to splintered pieces. The Gravettian is also known for the
527 vast array of burin types, considered as diagnostic elements of specific cultural facies diffused in a
528 short time-span at the regional or supraregional scale after the early Gravettian. This is the case of
529 the *Noailles* type, a burin spread from Western Europe to the Tyrrhenian coast of Italy (Palma di
530 Cesnola, 2001) and inland until the western slope of the Central Apennine at 28.6-28.0 ka cal BP
531 (Aranguren and Revedin, 2008), but which is completely absent in Adriatic Italy (Gambassini,
532 2007), the Balkan region (Mihailović and Mihailović, 2007) and Greece (Adam, 2007). Partition of
533 the middle phase of the Gravettian along the Italian Peninsula in two facies based on the presence or
534 absence of burins correlates to the biogeographic zonation described above.

535 Typological indications for industries of the oldest phase corroborate the hypothesis of the broad
536 expansion of the Swabian Gravettian and Pavlovian techno-complexes from Central Europe along
537 eastern routes, possibly supported by high mobility of hunter-gatherers. Large-scale movements of
538 people might have enhanced culturally mediated migrations and facilitated the diffusion and
539 assimilation of innovations in the technical behaviours of neighbouring regions (Moreau, 2009).
540 This could also have been the main factor leading to the first appearance of the techno-complex
541 with shouldered points (Fig. 5), the iconic tool of the third phase of the early Epigravettian, in
542 western Balkans and the GAPR refugia, settled by late Gravettians coming from the middle Danube
543 region. Kozłowski (1999; 2008) suggested to trace the occupation of this region by the early
544 Epigravettians on a morpho-stylistic comparative analysis with similar eastern types, like the
545 Kostienky and Willendorf ones. To this end, Broglio (1997) revealed a delayed trend in the
546 appearance of shouldered points according to the latitude position of the sites towards the south of
547 the Italian Peninsula based on the distribution of the dates which record the oldest at 25.8-24.8 ka
548 cal BP at Grotta Arene Candide (layers P9 and P8; Bietti and Molari, 1994), Grotta Paina, Ovčja
549 Jama and Šandalja II cave (although challenged from the date of layer 17E – 23.9-23 ka cal BP - at
550 Grotta Paglicci; Palma di Cesnola, 1993). More recently, alternative points of view have been
551 offered. After Borić and Cristiani (2016), it is possible that the design, manufacture and use of
552 shouldered points were transferred as a cultural package along networks developed between
553 populations, rather than these tools were directly spread in consequence of the movement of human
554 groups. Further on, the shouldered point as cultural marker has been challenged by the extension of
555 its chronological range. New dates from Kastritsa cave in Greece and Vrbička cave in Montenegro
556 shift the appearance of these points back to 28-26.7 ka cal BP, so much earlier than expected, with
557 persistence in their use until the end of the LGM and beyond it for a lapse of time in the late
558 Epigravettian. If this is the case, such a large chronological dispersion, which encompasses a
559 variability of ecological changes, does not reinforce the usefulness of this implement in the

560 identification of a specific cultural facies (Vukosavljević and Karavanić, 2017), and claims for
561 renewed analyses.

562 FIGURE 5 ABOUT HERE

563 According to the Laplace's model (1964; 1966; but see also Palma di Cesnola 1993; Bietti, 1997;
564 Broglio, 1997 for discussion), the early Epigravettian splits into three phases defined on a
565 typological ground: unifacial points, bifacial points and shouldered points, the first two interpreted
566 like the result of a cultural influence from the Solutrean spread in western Europe. Given the
567 sparseness of bifacial points, only the first and the third horizons show consistency, having been
568 recorded at several sites also on the Tyrrhenian side (Peresani, 2006). However, chronological
569 boundaries are still far from being positioned. Unifacial points are present in the final Gravettian as
570 much as in the earliest Epigravettian, leaving uncertainty for the cultural attribution of assemblages
571 to one or another techno-complex. Indeed, the Epigravettian is characterized by the persistence of
572 Gravettian traditions, as it has been presumed in the technology of lithic industries, despite the main
573 reference role assumed by the typology of tools and lithic insets. It has been claimed that
574 typological assets do not help to clarify the cultural consistency of the early Epigravettian, so its
575 chronological frame needs to be strengthened as much as information on the procedures of lithic
576 technology (Tomasso, 2017). Large uncertainty also concerns the upper boundary of the early
577 Epigravettian, being its latest appearances recorded at 21.8 ka cal BP at the top of the Arene
578 Candide sequence layer P1 (Bietti and Molari, 1994), at 20.9 ka cal BP at Trene, layer BI (Broglio
579 and Improta, 1995), and at a later range of 19-18.7 ka cal BP southward at Grotta Paglicci layers
580 13d, 13b and 12a (Palma di Cesnola, 2001) and Riparo Taurisano, spits 22-6 (Bietti, 1979).

581 Correspondingly, the chronological position of the lower boundary of the late Epigravettian is still
582 far from being secured. This second part of the Epigravettian is punctuated by increasing
583 innovations in lithic production especially in the time span between 15 and 11.5 ka cal BP which is
584 better investigated than others (Bertola et al., 2007; Montoya and Peresani, 2005; Fontana et al.,
585 2015; Montoya et al., 2018). Currently, lithic assemblages record the lack of shouldered points at
586 Baracche (Marche area) and Campo delle Piane (central Apennines) at 18.4-17.9 ka cal BP. Both
587 these open-air sites were extensively excavated (Olive, 2017; Peresani et al., 2005), thus yielding a
588 large amount of lithic artifacts with common tools and hunting implements. A later chronology is
589 provided by Tagliente rock-shelter in the Venetian Prealps, where the lowermost layers of the
590 Epigravettian series dating back between 17 and 16 ka cal BP, attest the presence of sporadic items
591 of this typology (Bartolomei et al., 1982; Fontana et al., 2012, 2015, 2018).

592 Trends driving responsive technology in tool making might have been encouraged by the possibility
593 to exploit Alpine territories previously inaccessible offered by the LG climatic and environmental
594 changes (Bertola et al., 2018). However, it is still unclear when changes in the technological know-
595 how occurred during the beginning of the late Epigravettian in the GAPR. Although there are traces
596 referring to the presence of hunter-gatherers on both edges of this vast region, the currently
597 available evidence remains too sparse yet.

598

599 **3.2. The Gravettian-Epigravettian settlement landscape: geographic coverage, chronology and** 600 **behavioural evidence**

601 Including sparse surface findings and open-air sites, most of the Gravettian – Epigravettian record
602 in the GAPR ranges from very close to the present-day coastline (Vlakno cave, 30 m amsl) up to
603 close to the Northern Apennine watershed (Piovesello, 870 m amsl), with the highest frequency
604 between 135 and 350 m amsl (Tab. 2, Figs. 3 and 9).

605 TABLE 2 ABOUT HERE

606

607 **3.2.1. Factors of bias**

608 Speculating about the organization of a settlement system extended in a now submerged geographic
609 zone like the Adriatic Plain could be meaningless due to weakened reliability of any proposed
610 scenario. The loss of a large continental land extent due to the rise of the sea-level during
611 Termination I was the most relevant change in the geographic setting of the GPP, leading to the
612 submersion of the Adriatic Plain. The incision of the Alpine alluvial megafans led to the
613 downstream formation of LG fans (Fontana et al., 2014a) alongside with the Apennine alluvial fans,
614 which also grew over the LGM plain (Amorosi et al., 2016). Wetlands and lowlands patterns on
615 marine coasts or around lakes and marshes, riverside forests, desert landscape were all potentially
616 settled environments, the exploration of which is prevented to us. Furthermore, also the paucity of
617 sites older than 14 ka cal BP, as it has been revealed in many traits of the GAPR and especially
618 along the foot of the Northern Apennines or in caves in the Dinarides (Vukosavljević and
619 Karavanić, 2017), could be interpreted in a contrasting way: should it be viewed as an expression of
620 sparseness human population compared to the later periods or as a lost of evidence determined by
621 intensive erosion and submersion? These factors contributed to set up an incomplete picture of a far
622 broader land-use, although the archaeological evidence provides a basis to infer coherent patterns of
623 local settlement systems.

624 A representative case is the northern Apennines, on the southern margin of the Po Plain, where
625 despite extensive surveying along the low terraces, no comparable archaeological evidence has been
626 documented. This makes the record extremely patchy and should suggest that this belt was
627 characterised by a dearth of settlements through all the Upper Palaeolithic (Lenzi and Nenzioni,
628 1996). However, land surface processes have been invoked in the above chapter as a bias factor
629 responsible for the absence of human traces in large areas, like this sector of the Apennines. The
630 landscape is shaped on mainly poorly lithified claystones, sandstones and marlstones, while caves
631 and shelters are limited to the karst complex of the Gypsum Ridge with fillings producing the only
632 Upper Palaeolithic record currently dated (ex. Cava a Filo; Paronuzzi et al., 2018b). In the more
633 external low hills and foothills huge colluvial and alluvial deposits deeply sealed the archaeological
634 sites. Surface findings are extremely sporadic in the numerous clay and sand quarries in the area.
635 One example is the Fornace San Damiano site in the Savio Valley, where a late Gravettian -
636 Epigravettian site was found, in a quarry, several meters below the ground surface and was partly
637 excavated. Among the artefacts found at this site, there are blades made of Umbria-Marche Scaglia
638 Rossa chert. This site attests human shifts along the Apennines slope between Marche and
639 Romagna (Guerreschi and Veggiani, 1983).

640 An additional factor of bias relates to the inhomogeneity of the resolution of archaeological
641 investigations carried out since the 50's of past century, when sites have been discovered in
642 intensively surveyed zones along the eastern Alpine range and foreland, on the Apennines foothills
643 range, in the Karst, in Istria and Dalmatia. Starting from the 80's, new Gravettian and Epigravettian
644 sites have been added to this heritage, only a part of which has been indeed investigated using
645 modern standards and multidisciplinary practices. As a consequence, archaeological evidence at the
646 northern and middle rim of the Adriatic basin is affected by variability in the density of
647 archaeological and osteoarchaeological materials as recorded at a number of sites.

648 The sites excavated until the 70's provided a lot of evidence and sometimes resulted in an
649 abundance of findings (see Malez, 1987; Palma di Cesnola, 2001, Bertola et al., 2007,
650 Vukosavljević and Karavanić, 2017 for lists and critical refinements). However, some uncertainties,
651 due to diversity in the documentation of the archaeological record, arose regarding the exact
652 provenance and stratigraphic position of the finds, and the lack of dating or of selective data
653 collection. Moreover, some of these sites have been studied with major detail with respect to others,
654 thus creating a bias in the comparison with contemporary sites. Part of these still requires in-depth
655 analyses, new sampling for geochronological data and re-assessment of faunal assemblages to avoid
656 underestimation in the accuracy of typo-technological contextualisation (Mussi and Peresani, 2004).

657 As an example, new chronometric data are needed in order to assess the consistency of the ^{14}C
658 chronological gap between the northern and the southern early Epigravettian sites previously
659 claimed by Broglio (1997) to support this technocomplex spread in later times to southern latitudes.
660 Another concern is the reliability of the cultural assemblages coming from the stratigraphy of
661 Šandalja II, a cavity in the Karst situated about 4 km north-east of downtown Pula in Istria. The
662 sedimentary succession was divided into eight units from layer H to layer A, with units C and B
663 divided into three subunits respectively, in addition to interface units (Malez excavations 1962-
664 1989; Malez, 1979; Miracle, 1994-1995; Karavanić 2003; et al., 2013). According to old ^{14}C dates
665 and cultural content, layer C/d at the base of unit C should belong to early Epigravettian (Karavanić
666 et al., 2013), while new but unpublished dates place layer C/d and the entire unit C into the late
667 Epigravettian (Miracle and Brajković, 2013). Lithic material from Layer D results from mixing of
668 both Aurignacian and Epigravettian elements (Karavanić et al., 2013). Furthermore, one of the two
669 dated samples from Aurignacian levels, is consistent with the Epigravettian and also suggests that
670 some mixing of material between different units took place (Richards et al., 2015).

671

672 3.2.2. Distribution of the radiocarbon dates

673 Except for some sparse surface findings and very few open-air sites, most Gravettian –
674 Epigravettian sites in the GPR were radiocarbon dated to the LGM chronological range (Tab. 2
675 and Fig. 6). Aside Piovesello, Riparo Broion, Stria, Rio Secco, Ponte di Pietra, Paina, Trene, Riparo
676 Tagliente, Romualdova Pećina and Campo delle Piane, only one date is available for each site or
677 layer from multilayered archaeological sites. Charred wood is the most dated material, followed by
678 animal bone, human bone (Tagliente), and organic silt associated with charcoal (Fonte delle
679 Mattinate). When additional dates were produced on bulk samples from palaeosoils (Fonte delle
680 Mattinate), we excluded the date from the list. Primary reference literature does not report any
681 information neither about the xilotoxic determination for charred wood samples (with the exception
682 of Buis dei Lader: *Larix*), nor about the taphonomy of animal bones (natural or anthropogenic
683 origin?). For most contexts, dispersed charcoal fragments were collected from archaeological
684 layers, with only few cases documenting sampling from fire-places (Riparo Broion, Campo delle
685 Piane) or from primary anthropogenic structures next to fire-places (Piovesello). Most dates were
686 made using AMS technique, some using conventional technique, producing large deviation ranges.
687 The dates cover with discontinuity the LGM range, being the Pećina kod Rovinjskog Sela 1 (Pećina
688 Cave near Rovinjskog Selo 1), Piovesello, Grotta Broion and Riparo Broion, Rio Secco and Fonte
689 delle Mattinate positioned in the 33-29 ka cal BP interval. Radiocarbon chronology at Grotta

690 Fumane in the Lessini Mountains marks one of the oldest range ever recorded in Europe for an
691 early Gravettian industry and it is currently under discussion. Sporadic lithic artefacts, backed
692 bladelets and one Vachons point were discovered in association with an extended accumulation of
693 charcoal in layer D1d, embedded in the detrital macro unit D, whose deposition filled-up the main
694 entrance of the cave (Falcucci and Peresani, in press). Following this first group of sites after a gap
695 of few thousands years, human presence is testified on the Berici Hills, the foot of the Marche
696 Apennine and in the Karst, starting from 25 ka cal BP in the late/final Gravettian and all along the
697 early Epigravettian until 21 ka cal BP. Dated sites are very sparse in the three following millennia,
698 provided by only one site in the Berici Hills (Stria) and in Northern Dalmatia (Vlakno) and by the
699 exception of Bùs dei Lader, a small cavity in the Prealpine foothills west of the Garda glacier front.
700 Although the charcoal fragment from Bùs dei Lader was determined as *Larix*, its association with
701 the only artifact found in 1956 during a survey remains uncertain (Biagi, 2000). Starting from 18 ka
702 cal BP, late Epigravettian groups settled at the foot of the Marche Apennine and then in Istria and
703 inland. Interestingly, after the collapse of the Garda glacier, human groups frequented persistently
704 the foothills of the Veneto Prealps (Tagliente) and inland in Western Mountain Croatia (Zala).
705 Given this distribution of the archaeological dated evidence across the LGM, the peopling of the
706 GAPR will be examined basing our assumptions on the currently available and original information
707 about the use of the ecological and petrological resources by the Gravettian – Epigravettian hunter-
708 gatherers. Four main cultural-temporal ranges will be considered to facilitate our view on how the
709 use of this vast land evolved: 32-29, 26-23, 23-19, 18-16 ka cal BP, corresponding approximately to
710 the early Gravettian, the middle (evolved) and late (final) Gravettian, the early Epigravettian and the
711 earliest part of the late Epigravettian. The lack of dates between 29 and 26 ka cal BP does not
712 support a complete scenario of settlement dynamics during the Gravettian.

713 FIGURE 6 ABOUT HERE

714

715 3.2.3. Early Gravettian

716 A paucity of sites features the Gravettian since its oldest phase (Tab. 2, Figs. 6 and 9a) leaving the
717 middle (evolved) phase ephemerally recorded by archeological evidence. Data currently available
718 are from Piovesello and Fonte delle Mattinate on the Apennine watershed, Grotta Broion and
719 Riparo Broion in the Berici Hills, Rio Secco in the Carnic Prealps and Pećina kod Rovinjskog Sela
720 1 in Istria. All together, these sites record human presence at the edge of the settled landscape.
721 Piovesello dates to 30 ka cal BP and is an open-air site located at 870 m amsl on the edge of a
722 shallow wet basin, in an arid cold environment slightly above the timberline, climatically correlated

723 to GS-5 (Peresani et al., 2018). The site attests short-term frequentations of a small group mostly
724 equipped with raw blocks of red radiolarite collected a few kilometres away (Peresani et al., 2018).
725 By contrast, a handful of finished artefacts have further provenance, suggesting long-range mobility
726 from south-eastern France. Multiple refittings are ascribable to complete reduction sequences on
727 local raw material, with prevalence of maintenance flakes and blades and maintenance products,
728 underrepresentation of end-products and very few retouched tools (Peresani et al., 2018; Zangrossi
729 et al., 2019).

730 Grotta Broion yielded a handful of blades, bladelet waste products and a few retouched tools from
731 layers C, D and E in the main cavern (Sala Grande) and in a small lateral cavity (Grottina delle
732 Marmotte) (Leonardi and Broglio, 1951, 1954). Riparo Broion was settled before and in the same
733 chronological range as Grotta Broion. Typological features of the backed points and backed
734 bladelets found in layer 1c suggest their attribution to the Gravettian (De Stefani et al., 2005).
735 Typological imbalance in assemblages in layers 1a, 1b and correlate, plays in favour of *gravettes*
736 and *microgravettes* and backed bladelets and, in addition to the presence of impact fractures on
737 these artifacts, points to interpreting this settlement as strictly related to hunting parties (De Stefani
738 et al., 2005). The previous attribution (De Stefani et al., 2005) of these layers to the early
739 Epigravettian was based on the presence of fragmented shouldered points, unifacial leaf pieces and
740 one radiocarbon date (UtC-10506). This was challenged by the same authors (De Stefani, pers.
741 comm), who marked out typological similarities and differences respectively for *gravettes* at
742 Paglicci cave (Palma di Cesnola, 2004) and shouldered points at Paina, Trene and Buso Doppio
743 caves. Further dissimilarity raised from noting that the chert used for shouldered points at Riparo
744 Broion is of local provenance in contrast with the exotic material used at Paina, Trene and Buso
745 Doppio. Grotta Rio Secco attests ephemeral frequentations, represented by few common tools (one
746 end-scraper, burin-cores), backed points and bladelets recovered sparse in layers 4 and 6 where
747 remnants of fire-places were also brought to light (Peresani et al., 2014).

748 The early Gravettian record appears too ephemeral also in Western Dalmatia and Istria to estimate
749 the nature of human presence. However, systematic excavations carried out between 2014 and 2018
750 at rockshelter Abri Kontija 002 on the northern side of the Lim channel in the western part of Istria,
751 yielded consistent archaeological evidence (Janković et al., 2015). This is represented by traces of
752 fire and burnt bones, faunal remains, ochre and several thousand of lithic artifacts and small chips.
753 Most common retouched types are backed bladelets and marginally retouched bladelets.

754 Radiometric dates (unpublished, I. Janković) confirm this was one of the earliest sites with backed
755 tools in the eastern Adriatic. Pećina kod Rovinjskog Sela 1 is located in the close proximity of

756 Romualdova pećina and Abri Kontija 002. Evidence of Gravettian frequentation represented by
757 lithics, faunal bones and marine shells was produced from a survey in 2007.

758 A context partly comparable to Piovesello has been reconstructed from geoarchaeological
759 investigation on the Marche Apennines watershed at Fonte delle Mattinate on the Colfiorito plateau,
760 where evidence of early Gravettian frequentation has been related to the interval between GI-5 -
761 HE3. Archaeological data point for a camp, where the acquisition and processing of cherts were
762 aimed to accomplish immediate tasks. Worked or semi-worked products were introduced by
763 hunter-gatherers that inhabited this plateau for short term, recurrent, frequentations. Further later
764 traces of frequentation date to HE3 and relate to harsher physical and ecological conditions
765 constraining human mobility in the innermost zone of the central Apennine (Giaccio et al., 2004;
766 Silvestrini et al., 2005a).

767

768 **3.2.4. Middle (evolved) and late (final) Gravettian**

769 The middle (evolved) and late (final) Gravettian record is ephemeral in the north Adriatic rim (Fig.
770 9b). In the Berici Hills, similarly to the Gravettian at Riparo Broion, typological imbalances are
771 dominated by backed points at Paina (layer 7), Trene and Stria caves, settled probably later. At
772 Cava a Filo, in the central section of the Northern Apennines (n. 27 in Fig. 3), of the
773 palaeontological amount of large artiodactyls, few *Bison priscus* bones grooved by cut-marks
774 associated with a few lithic implements point for human frequentation of this low altitude hilly
775 landscape not later than 24.2 ka cal BP (Paronuzzi et al., 2018b).

776 More to the south, in proximity of the western margin of the AP, the late Gravettian is recorded in
777 the low hills of the external belts of the Apennines (Broglia et al., 2005). Archaeological evidence
778 points to an exclusive presence of open-air sites, close to streams and major rivers, at the lower end
779 of gorges. Such sites were devoted to extractive and productive activities undertaken during short-
780 term visits. The set of available radiocarbon dates, for instance, constrains the occupation of Ponte
781 di Pietra and Fosso Mergaoni sites between 25.2 and 20.9 ka cal BP and between 22.5 and 21.4 ka
782 cal BP. Ponte di Pietra is situated along the river Misa, in a district plenty of excellent lithic
783 resources (Lollini et al., 2005). Fosso Mergaoni is mainly featured by two groups of lithic
784 workshops scattered on the alluvial ground. The spatial pattern with intra and inter-workshop
785 refittings, the paucity in retouched implements, the technological composition of the lithic artifacts
786 concentrations, the low incidence of use-wear related to the acquisition of alimentary resources and
787 to the processing of animal resources observed on a sample of artifacts, prove that the site was
788 functionally aimed to lithic production. Presumably, it was an area nearby a camp or part of a

789 settlement system related to the fluvial basin and its lithic resources (Cancellieri, 2015; Silvestrini et
790 al., 2005b; Ziggiotti, 2007). At both sites, lithic sets define the existence of lithic workshops in
791 proximity of possible dwelling areas. These include core shaping flakes, cores, laminar products
792 and different by-products resulting from the production of large blades, blades and bladelets from
793 chert nodules collected very close to the site. Technological composition, rare retouched
794 implements and spatial patterns, are indicative of specialized tasks consisting of the extraction and
795 knapping of fine-grained chert nodules (Cancellieri, 2015).

796

797 3.2.5. Early Epigravettian

798 Additional data are available for the early Epigravettian along both the Adriatic sides (Fig. 9c). In
799 the Berici hills, the lithic industries consistently include a number of end-products like blades and
800 bladelets, shouldered points and *microgravettes* backed points. Minimal archaeological remains
801 have been recovered in the same string of caves and rockshelters previously settled during the
802 Gravettian: Trene, Paina, Stria and Buso Doppio. Typological assemblages are dominated by
803 weapons for huntings (backed points and backed bladelets) together with unretouched blade and
804 bladelet blanks. Shouldered projectile points found at Paina and Trene bear impact scars, which
805 consistently provide hints for interpreting these contexts like short-lived campsites and hunting
806 stands (Broglio et al., 1993; 2009). At Buso Doppio Broion, recent excavations brought to light a
807 sequence where the uppermost layer 1tt.II and reworked sediments yielded backed and shouldered
808 points (Romandini et al., 2015). According to the radiocarbon date, the presence of fragmented
809 shouldered points and of unifacial leaf pieces mentioned above, Riparo Broion was settled during
810 the early Epigravettian (De Stefani et al., 2005). A marginally retouched point is the only
811 archaeological find recovered at Bùs dei Lader (Biagi, 1976). No data on the early Epigravettian
812 settlement at Stria Cave have been produced yet.

813 The site Madonna dell'Ospedale lies on a fluvial terrace along the Rudielle stream valley, one of the
814 incisions which dissects the Cingoli Mountain ridge (Marche Apennines). Chert in this zone,
815 especially from Maiolica and Scaglia, is of the most excellent in the Marche Apennines. The site
816 has been culturally attributed on a technological and typological basis (shouldered points) and
817 interpreted as specialized for the production of blanks and the manufacture of hunting weapons
818 (Silvestrini et al., 2008; Cancellieri, 2015). In the north-western Balkans, the earliest spread of the
819 early Epigravettian comes from Šandalja II. In the Slovenian karst, reference sites for the early
820 Epigravettian are Zakajeni Spodmol, Ovčja Jama, Županov Spodmol and Jama V Lozi (with one
821 shouldered point) (Montet-White, 1996). A shouldered point was found at Romualdova pečina,

822 another site on the Lim channel in Istria also known for cave paintings likely attributed to the
823 Aurignacian (Ruiz-Redondo et al., 2019). Similarly to the Berici area, cave and sheltered sites are
824 generally interpreted as temporary encampments located along mobility routes used by small groups
825 of hunters, which is suggested by the limited amount of tools and the ephemeral indications of
826 knapping activity. In some cases, like at Županov Spodmol, Epigravettian groups reached the cave
827 equipped with finished tool kits as well as some cores that were further exploited on site. In the case
828 of Ovčja Jama, a more intensive use of the site is documented, along with a possible longer-term
829 occupation (Montet-White, 1996).

830 More to the south, Vlakno cave locates on the northwestern side of Dugi Otok Island, the biggest
831 and longest of the Zadar archipelago. The sedimentary sequence has produced evidence of human
832 frequentations dated from the late LGM until the end of the Holocene (Vujević and Parica, 2009;
833 Vukosavljević et al., 2014; Cvitkušić et al. 2018), and embeds the Neapolitan Yellow Tuff in its
834 central part. The composition of the lithic and faunal assemblages from layers 27-33, sealed by the
835 tuff, points to an intensive use of the cave. Backed bladelets and blades, and backed points largely
836 prevail on the other tool types, despite excavated in a limited survey (Malnar, 2017).

837

838 **3.2.6. Late Epigravettian >16ka BP (Fig. 9d)**

839 The evidence from Riparo Tagliente is more consistent than the sites described above. This site
840 attests the first re-occupation of the south-eastern Alps at the end of the LGM, starting from 17 ka
841 cal BP, in a steppe-forest environment with increased density in conifers at 16.5 ka cal BP (Ravazzi
842 et al., 2014). The favourable position of the site at the crossway between different ecotones and its
843 location along the corridor of Valpantena giving access to the Lessini plateau and the inner Alps
844 have enhanced its intense occupation along time (Fontana et al., 2009). All late Epigravettian layers
845 document an intense activity of exploitation of the Lessini abundant chert outcrops and ochre
846 deposits (Fontana et al., 2015; Cavallo et al., 2017), while in the area protected by the over-hang of
847 the shelter several dwelling structures were uncovered (Fontana et al., 2018). Tagliente has also
848 yielded one of the most important Epigravettian collections of tools made of animal hard materials
849 and ornamental objects, as well as a series of mobile art objects and a burial dated to 16.6-15.5 ka
850 cal BP (Guerreschi and Veronese, 2002; Gazzoni et al., 2013).

851 In southeastern Istria, Ljubićeva pećina cave is a multistratified site with lithic artifacts represented
852 by blades, bladelets, backed blades, bone tools and other finds (Percan et al., 2008; Simonet, 2013;
853 Janković et al., 2015). More inland, ca. 50 km acf from the present-day coast, Zala cave locates
854 between the eastern Peri-Pannonian and western mountainous Croatia, where the Pannonian Plain is

855 closest to the Adriatic Sea. Short-term human frequentations are recorded by a small amount of
856 lithic artefacts. Blades are produced off site, backed bladelets are the most frequent tool type,
857 endscrapers and other domestic tools are also present, suggesting that different activities were
858 carried out during short stays (Vukosavljević et al., 2015). Aside the radiocarbon date, no detail on
859 human frequentation at Romualdova are currently known.

860 Baracche lies on a Late Glacial gravelly alluvial terrace along the same incised valley of Madonna
861 dell'Ospedale at the foot of the Cingoli Ridge. This open-air site includes lithic workshops aimed to
862 the exploitation of local chert nodules, as it has been inferred from the litho-technological features,
863 the structures and the refittings (Peresani et al., 2005).

864 Campo delle Piane CDP 7 lies on a Late Glacial alluvial terrace of the Gallero creek, a tributary of
865 the Tavo River, in a hilly landscape of the Abruzzo fore-Apennine. These terraces were extensively
866 settled, and human occupation in CDP 7 correlates to a pedogenetic phase developed during the
867 Greenland Stade 2b in an open landscape with sparse pine trees. Interpretation of different sources
868 of archaeological evidence points to an open-air site organised around fire-places associated to
869 lithic workshops (Olive, 2017).

870

871 **3.3. Exploitation of faunal resources**

872 Only a handful of sites has produced zooarchaeological data testifying for game hunting. This is the
873 case of caves in the Berici Hills, where bone remains attributed to ungulates and carnivores record
874 the exploitation of resources available in the surroundings. Traces of human modification have been
875 observed on cervids (*Cervus elaphus* and *Alces alces*), caprids and wild boar as well as on cave
876 bears (*Ursus spelaeus*, sensu lato) at Paina, Trene and Buso doppio Broion (Romandini and
877 Nannini, 2012; Romandini et al., 2015). Cut-marks on several bear remains enable a reconstruction
878 of the main steps of fur recovery and the butchering process (Romandini and Nannini, 2012). In
879 Istria and western mountainous Croatia, Šandalja II and Zala caves are the only source of
880 zooarchaeological evidence. At Zala, hunters targeted red deer and moose more than auroch (*Bos*
881 *primigenius*). Similarly to the Berici Hills caves, carnivores like brown bear (*Ursus arctos*) and
882 wolf (*Canis lupus*) were processed, as attested from butchery marks (Radović, 2015).

883 At Šandalja II, layer C/d gave evidence of human exploitation of horse, large bovids (more aurochs
884 than bison), large cervids and small carnivores like fox (*Vulpes vulpes*) and badger (*Meles meles*).
885 The top of layer C records continuity in the exploitation of this game, the moose being included
886 among large herbivores and wild cat among the small carnivores (Miracle, 2007). Furthermore,

887 isotopic analysis of carbon and nitrogen bone collagen of faunal and human remains from late
888 Epigravettian layers, identifies freshwater fish in human diet as the main protein sources, although
889 large herbivores are represented at the site (Richards et al., 2015). A red deer dominated faunal
890 assemblage with chamois, ibex and few horse, hare, and fox was the exploited game around Vela
891 špilja cave (Lošinj Island), similarly to Pupičina and Nugljanska caves in the Kvarner region, in the
892 lower layers, undated, but preceding the interstadial warming. In addition to these sites, ephemeral
893 evidence is reported from Vešanska cave with assemblage consisting of red deer and marmot
894 (Miracle, 2007).

895

896 **4. Human mobility across the Great Adriatic-Po Region inferred from petroarchaeological** 897 **evidence**

898 One of the clearest evidences of a large scale network of contacts between hunting bands and/or of
899 their high mobility across the GAPR is given by petrographic data on the provenance of lithic raw
900 materials, complemented by similarities in lithic industries from sites in north-eastern Italy,
901 Slovenia and Istria (Broglia, 1994). However, our knowledge on the use and circulation of cherts
902 from the GAPR is sparse and biased by differences in the development of investigations. Some
903 information is available in the literature for most of the sites taken into account in this work and
904 additional data are provided from new studies presented here. For the purpose of this investigation
905 aimed to achieve indicators of chert provenance, petroarchaeological data are presented only at
906 qualitative level. For access to computations of each lithic assemblage see references in tables 2 and
907 4.

908

909 **4.1. A view on the distribution of chert bearing rocks along the GAPR**

910 In the Southern and Eastern Alps, the Dinarides and the Apennines, the knappable lithic resources
911 are represented mainly by cherts and radiolarites which differ in lateral and stratigraphic
912 distribution according to the regional palaeogeographic domains. Southern Alps, Dinarides and
913 Eastern Alps share a common paleogeographic and tectonic evolution since late Triassic and each
914 domain was composed of different sub-domains such as shallow-water platforms, submarine
915 plateaus and deep basins. Detailed regional studies, mainly aimed to recognize in the field the
916 palaeogeographic borders of the major structural elements, the main depositional features of the
917 basins were reconstructed both in time and space (e.g., Auboin, 1963; Bosellini, 1965, 1973;
918 Winterer and Bosellini, 1981; Bertotti et al., 1993; Santantonio and Carminati, 2011; Schettino and

919 Turco, 2011). This approach allowed identifying certain regional lithic raw materials markers or
920 “guide-fossils” such as, for example, the Eocene Scaglia Rossa chert of the Umbria-Marche
921 Apennines.

922 In the Neotethys basinal domains of the Southern Alps, there are thick Jurassic-Eocene cherty series
923 (Calcari Grigi, Rosso Ammonitico, Maiolica, Scaglia Variegata Alpina, Scaglia Rossa, Scaglia
924 Cinerea) with abundant chert nodules and beds, some of them with exceptional rheological
925 properties due to their fine texture and homogeneity. Over the submarine plateaus, the series are
926 much more condensed and with different features both in sedimentary sequences and chert
927 properties. In adjacent areas such as the Karst or Dalmatia, where sea depths were shallower during
928 the Jurassic and Cretaceous (Friuli shelf), cherts are scarce and confined to few epicontinental
929 basins. The Umbria-Marche area (easternmost Northern Apennines) was a different sector of the
930 epicontinental (Adria microplate) basinal domain of the Neotethys, where very thick cherty
931 sequences developed, with some differences with respect to the ones of the Southern Alps (Fig. 7
932 and Tab. 3); this basin was delimited to the south by the Ancona-Anzio line, separating from the
933 Lazio-Abruzzi shallow shelves.

934 FIGURE 7 AND TABLE 3 ABOUT HERE

935 Since the Oligo-Miocene, at the foot of the Alps, the Venetian-Friulian foreland basin developed
936 (Massari et al., 1986; Stefani et al., 2007) and the cherts, eroded from the Southern Alps, were
937 redistributed in the clastic wedge; the coarser are preserved in the Montello, and other
938 conglomerates (Massari et al., 1974). At the same time, at the front of the Apennine chain, very
939 deep foreland basins formed, and the distribution of the Oligo-Miocene cherts in the northern
940 Apennines is mainly linked to the evolution of these basins NW-SE or even N-S oriented. In this
941 case, most of the cherts are of Oligo-Miocene age and formed in very deep foreland basins. Each of
942 the quoted paleo domains was influenced by specific sedimentary processes and dynamics and
943 developed at different times, thus giving distinct features to each group of cherts.

944 Cherts in these regions crop out in the sedimentary rocks as nodules or layers, different in size, and
945 colour, texture, structure, paleontological content, silicification degrees and tectonic integrity
946 (Bertola, 2012, 2016). In the less deformed areas, chert layers or nodules are easily collectable near
947 primary outcrops but also as cobbles or blocks transported in the valleys bottom, along stream-beds
948 and alluvial deposits. Blocks and pebbles have different utility in function of the average size,
949 which is quite big and suitable for a range of sized blade and bladelet production (Cancellieri,
950 2015). Small sharp edged blocks, suitable for bladelet making could be collected in slope waste
951 deposits and soils.

952 In the Karst and Dalmatia, cherts are scarce and confined to few epicontinental basins.
953 Allochthonous siliceous clastic deposits of the Triassic, devitrified tuff and siliceous claystone
954 (green stone), and only a minor degree radiolarite and chert, occur on the northern side of the
955 Velebit Mountain (Sokač, 2009) and in primary exposures in the hinterland of Dalmatia in the
956 vicinity of Muć (Šćavničar et al., 1984), as well as on the Island of Palagruža (Korbar et al., 2009).
957 Upper Jurassic chert of poor quality to knapping are documented on islands in Dalmatia (Velić and
958 Vlahović, 2009). Conversely, upper Cretaceous (Cenomanian – Maastrichtian) chert of markedly
959 different quality is provisionable on limited outcrops scattered throughout Dalmatia and on the
960 Dalmatian islands of Korčula, Brač, Dugi Otok and in the subregion Zagora (Fuček, 2009; Perhoč,
961 2009, 2020). Chert is largely more frequent in the Lower to Middle Eocene Foraminifera limestones
962 and in the Middle to Upper Eocene Flysch exposures than in the upper Cretaceous one (Sikošek,
963 1971; Perhoč 2020). Also, in Istria chert is embedded in Cretaceous limestone (Šikić and Pleničar,
964 1975; Polšak, 1970; Šikić and Polšak, 1973), exceptionally in Jurassic deposits of plate limestone
965 (Polšak and Šikić, 1973). Small outcrops are scattered through the region, with highest
966 concentration in the southern part on the Premantura Peninsula near Medulin and Bay. Primary
967 chert outcrops also distributes in central Istria and on mountains Učka in western and Ćićarija in
968 northern Istria.

969 There are no primary radiolarite sources in Dalmatia and Istria. Allochthonous sources have been
970 recorded in gravel alluvial deposits of Reka River in the Primorska-Notranjska regions of Slovenia
971 (Šikić and Pleničar, 1975; Perhoč, 2020) and in glacial-fluvial sediments near Ozalj in Croatia,
972 reworked from Kupa River (Perhoč, 2020; Vukosavljević et al., 2015). Pebbles of radiolarite,
973 together with chert and quartz sandstone are a fraction of Eocene conglomerates in the Ravni kotari
974 area in Dalmatia (Vlahović and Velić, 2009). Extensive primary and secondary sources of
975 radiolarite are part of the Ophiolite complex of Central Dinarides, in the Banovina region (Šikić et
976 al., 2009) and in Bosnia and Herzegovina (Šegvić et al. 2014; Perhoč, 2020). Because during the
977 LG it could transport radiolarite pebbles at least down to the islands of Hvar and Korčula, the
978 Neretva River is of particular interest among the Bosnian rivers (Sikora et. al., 2014; Perhoč, 2020).

979

980 **4.2. Petroarchaeological evidence from Gravettian-Epigravettian sites: materials and methods**

981 Investigating human mobility across the GAPR requires detailed determinations on the knappable
982 materials used at Gravettian - Epigravettian sites located at far distance from the primary
983 workshops. We selected 27 sites: 16 were previously petroarchaeologically investigated in the last

984 two decades; six are the subject of this study, and five are left outside from this study for reasons
985 due to unaccessible or not yet analysed material (Tab. 4).

986 Geological surveys conducted previously the present work have produced qualitative data on the
987 distribution and properties of the knappable rocks from primary outcrops and secondary deposits in
988 representative type areas. Cherts have been studied with a geological approach, considered as part
989 of the outcropping formations, the latter ratified by the International Commission of Stratigraphy
990 and, for the Italian territory, mapped by the ISPRA. The systematic prospecting and sampling,
991 carried on since the 90's of the 20th century by one of the authors (SB) and other researchers of the
992 Ferrara University, on the Southern Alps and Northern Apennines, allowed to build a large and
993 diversified siliceous raw materials collection (lithotheque) stored in the Dipartimento di Studi
994 Umanistici of the University of Ferrara. The lithotheque is widely representative both of the lateral
995 (areal) and vertical (stratigraphic) variations of the cherts in the different outcropping formations; it
996 represents a powerful database for analysis and comparisons with the archaeological collections.

997 In addition to this lithotheque, this work has also considered two other raw materials collections. The
998 first from the Marche Apennines, in the Gola della Rossa e Frasassi Natural Park, where chert
999 sources were surveyed, mapped and characterized. Moreover, availability and suitability of cherts
1000 were tested through the sampling of selected areas and their classification in accordance with the
1001 flaking attitude (Cancellieri, 2015). This collection is stored in the Dipartimento di Studi Umanistici
1002 of the University of Ferrara as well. The second raw materials collection covers Istria and Dalmatia,
1003 where systematic researches on lithic collections and outcropping knappable rocks have been
1004 carried on in the last two decades (Perhoč, 2009; 2020). This lithotheque is stored at Zlatko Perhoč's
1005 home, Mannheim, Germany.

1006 We attributed the archaeological cherts (lithic artefacts) to their respective geological formations
1007 through the analysis of diagnostic features such as: color, cortex features, petrographic textures and
1008 structures, micropaleontology, mineralogy and rheology (i.e. Tab. 3, Fig. 8). Chert colors were
1009 compared with the Munsell Soil Color Charts® (Munsell Color, 2001) and the Rock-Color Chart®
1010 (Geological Society of America, 1964). In a second step, the geographic provenance of the cherts
1011 was tentatively circumscribed on the basis of laterally variable features within the same formation.
1012 Important additional information was inferred by the presence, on the artefacts, of natural surface
1013 features (alterations on cherts and cortexes, patinas, rounding) referable to the collecting contexts of
1014 the cherts like soils or paleosoils, slope, present stream channels and coarse alluvial deposits.

1015 We finally scrutinized under multivariable optical stereomicroscope (Optika SZ series, 45X with
1016 camera Moticam 3+ USB 3) the microfacies (petrography, mineralogy, microstructures, inclusions,

1017 microfossils) of the geological and archaeological cherts. Additionally, we analysed with a
1018 mineralogy microscope (Olympus BX40) under polarized light the thin sections of some geological
1019 cherts of the area.

1020 We determined microfossils using comparison atlas (Robaszynski and Caron, 1995; Bolli et al,
1021 1985; Premoli Silva and Sliter, 1995, 2002) and other references (among them Cita, 1964; Erba and
1022 Quadrio, 1987; Luciani, 1989; Sliter, 1989).

1023 FIGURE 8 ABOUT HERE

1024

1025 **4.3. Results** (Tab. 4 and Fig. 9)

1026

1027 **Northern Apennine**

1028 *Piovesello, Gravettian*. In this site, the local red and brown radiolarites (Monte Alpe Cherts
1029 formation, Ligurids, Jurassic) were mainly exploited but it is also attested the introduction of few
1030 finished hunting implements, domestic tools and one bladelet core made of chert from the Apt-
1031 Foucaquier basin (Vaucluse-Haute Provence, 300 km far), plus the in-site production of bladelet
1032 blanks, retouching and re-tooling (Peresani et al., 2018) (Tab. 4 and Fig. 9a).

1033

1034 **Venetian and Friulian Prealps**

1035 *Grotta Fumane, Unit D, Gravettian*. Finished hunting tools, blades and bladelets record sporadic
1036 occupations of the cave and attest the exclusive use of the local resources from Lessini mountains
1037 (Bertola et al., 2018) (Tab. 4).

1038 *Grotta Rio Secco, layer 6, Gravettian*. Chert has been provisioned in a radius of 50 km from this
1039 site in the Carnian Prealps where different Triassic to Cretaceous formations outcrop, uplifted and
1040 deformed from intense and still active tectonic activity: Buchenstein, Soverzene, Igne, Verzegnis,
1041 Fonzaso, Maiolica, Scaglia Variegata Alpina, Scaglia Rossa. Well rounded cobbles are among the
1042 finest knappable material, collectable in the Tertiary Flysch and Molasse in the Carnian foothills
1043 and redeposited after erosion on the Tagliamento end-moraine system and the Tagliamento, Isonzo
1044 and Cormor alluvial beds, originally included in the Tertiary deposits (Tab. 4 and Fig. 9a). Among
1045 these cobbles, the most appreciable cherts belong to Maiolica and Fonzaso. Cobbles up to 6-8cm
1046 were exploited to produce bladelets or short blades. Longer blades were produced from cherts

1047 gathered on the poorly tectonized outcrops of the Maiolica and Scaglia Variegata Alpina. Common
1048 tools such as scrapers are frequently made out of flakes or on by-products (Peresani et al., 2011).

1049 *Grotta Broion (layers C-E), Gravettian.* There are a few artifacts made with different chert types
1050 from the Berici Hills and Euganei Hills (5-15 km) and the Lessini Mountains (25-50 km), the latter
1051 chosen especially for blade production (Bertola et al., 2018) (Tab. 4 and Fig. 9a).

1052 *Riparo Broion, US 1a-d. Gravettian.* Similarly to the Grotta Broion, the exploited raw materials
1053 comprehend regional chert types from the Berici, Euganei and the Lessini. There are many affinities
1054 both in raw material and typology (De Stefani et al., 2005; Bertola et al., 2018) (Tab. 4 and Fig. 9a).

1055 *Grotta Paina, Sala Azzurra, layers 7 and 6, Gravettian and early Epigravettian.* Both assemblages
1056 (Bartolomei et al., 1985) contain a few lithic tools (23 and 47 respectively) almost entirely made of
1057 allochthonous chert (78% and 89%; Broglio et al., 2009). Varieties belong to the Maiolica, Marne a
1058 Fucoidi, Scaglia Rossa, Scaglia Variegata (Tab. 3, Figs. 10.7 and 10.8) formations outcropping in
1059 the Umbria-Marche region (Tab. 4, Figs. 9b and 9c). There is no evidence of intra-site flaking or
1060 retouching of these allochthonous raw materials. The scarce Berici-Euganei chert artefacts are all
1061 unretouched and consist of blade and bladelet fragments but also cortical flakes and small flakes
1062 (*debris*), attesting sporadic flaking activities at the site. Four backed bladelet fragments are made of
1063 excellent Lessini cherts of the Scaglia Variegata Alpina; these pieces were introduced finished onto
1064 the site (Broglio et al., 2009; Bertola et al., 2018).

1065 *Grotta Paina, Sala Terminale, layers B-C, 21-29 and 125, Gravettian and early Epigravettian?*
1066 Similar to above considerations could be advanced for the excavations carried out in the Sala
1067 Terminale (Leonardi and Broglio, 1962). Upper layers are in great part reworked and contain
1068 *gravettes* and shouldered points comparable to the Grottina Azzurra series, layer 6. Lower layers
1069 contain fragmentary armatures without shouldered points, and are comparable to the Grottina
1070 Azzurra series, layer 7. The raw materials entirely come from the Umbria-Marche region (Broglio
1071 et al. 2009; Bertola et al., 2018) (Tabs. 3 and 4, Figs. 9c and 10.11).

1072 *Buso Doppio Broion, layers 1 and RIM, early Epigravettian.* Among the 46 studied artifacts
1073 (Bertola et al. 2018), 17 are made with allochthonous Umbria-Marche basin cherts, most of them
1074 shaped like backed and shouldered points together with a few unretouched blades and bladelets.
1075 Cherts show greater variability with respect to the previous described assemblages, possibly
1076 suggesting different or wider exploitation areas (Tab. 4, Fig. 9c). They belong to the following
1077 formations: Bisciario, Scaglia Cinerea, Scaglia Rossa, Scaglia Bianca, Marne a Fucoidi and Maiolica
1078 (Tab. 3, Fig. 10.10). Lessini cherts are represented by seven artefacts, six of them retouched

1079 (backed tools) and one crested bladelet. The Berici-Euganei cherts artefacts (26) were also flaked
1080 on site to produce blade, bladelets and backed tools, but not the shouldered points. (Romandini et al.
1081 2015; Bertola et al., 2018).

1082 *Grotta Trene, layer B, early Epigravettian*. Of the total assemblage (33 lithics), ten are retouched
1083 tools: nine are made of allochthonous Umbria-Marche cherts (Scaglia Rossa, Maiolica and Marne a
1084 Fucoidi) and one, a leaf point, of Scaglia Variegata Alpina from the Lessini. All the remaining
1085 artefacts are unretouched and made of local cherts from the Berici Hills and Euganei Hills (19) or of
1086 the Lessini (4) (Broglia et al., 2009; Bertola et al. 2018) (Tabs. 3 and 4, Figs. 9c and 10.9).

1087 *Riparo Tagliente, layers (SU) 15, 15a, 13a, 13a alfa, 13a beta, 250, 300, 360, 307. Early Late*
1088 *Epigravettian*. In these layers, among a dominant exploitation of the excellent local Lessini cherts,
1089 recent studies have isolated a group of implements made on extra-regional cherts, quite all
1090 belonging to the Umbria-Marche basin Scaglia Rossa lithotypes absent from the same areas
1091 exploited by the late Gravettian and the early Epigravettian hunter-gatherers who settled the area of
1092 the Berici Hills. A total of 48 artefacts on Scaglia Rossa (mostly Eocene) and three on Calcari
1093 Diasprigni (upper Jurassic) Umbria-Marche cherts were identified (Tabs. 3 and 4, Figs. 9d and
1094 10.12). The assemblage includes 13 retouched tools (among which nine backed fragments, one
1095 burin, one endscraper, one truncated blade and one pointed piece), 35 unmodified blanks (including
1096 bladelets, flakes, semi-cortical blanks and maintenance elements) and three bladelet cores (Bertola
1097 et al., 2018). Allochthonous Apennine cherts reduce in number in the later times during the LG
1098 interstadial.

1099 FIGURES 9 AND 10 ABOUT HERE

1100

1101 **Karst, Istria and Dalmatia**

1102 *Šandalja II cave, layer C/d, early Epigravettian*. In our preliminary study, petrographic
1103 determinations were not completed with computation of the overall assemblage of layer C. Raw
1104 materials from different paleogeographic areas have been identified, comprehending local (Istria)
1105 but also more distant sources like the eastern Southern Alps (Friuli/Veneto) and very distant
1106 allochthonous ones (Umbria-Marche) (Tabs. 3 and 4, Fig. 11). Prealpine chert was possibly collected
1107 as cobbles in the vast gravelly alluvial plains of the Isonzo and Tagliamento. Among these
1108 materials, Triassic (Ladinian) Buchenstein cherts, Jurassic Soverzene/Igne and Fonzaso cherts (Tab.
1109 3, Figs. 11.17 and 11.18) and probably also a kind of Maiolica (with bioturbations, typical of the
1110 Southern Alps) were identified as well. Among the local cherts, there are easily recognizable types,

1111 deposited in shallow waters, with evident stripes (stromatolitic laminae, algae) often with a
1112 brecciated appearance. Regarding the lithic industry made on raw materials from Umbria-Marche,
1113 artefacts made on Scaglia Rossa (Eocene layers; Fig. 11.13) and Maiolica (Tab. 3, Fig. 11.15) have
1114 been also identified, including some shouldered points. Attributing additional lithotypes featured
1115 from fine crystalline gray to yellow color, and radiolarians and *Rotalipora* (Albian/Cenomanian)
1116 has been more problematic due to the existence of petrographic similitudes in cherts shared between
1117 the Umbria-Marche Apennine and the Southern Alps. For these types more detailed analyses will be
1118 required. Artefacts made of yellow fine crystalline chert with radiolarians and *Rotalipora*
1119 (Albian/Cenomanian) likely attributable to the Scaglia Variegata Alpina (Southern Alps,
1120 Friuli/Veneto regions) or to the Scaglia Bianca (Umbria-Marche) are also present in layer B/C.

1121 *Romualdova pećina, no context, early Epigravettian.* We identified chert of Umbria-Marche Scaglia
1122 Rossa on one shouldered point (Tabs. 3 and 4, Figs. 9d and 11.14).

1123 *Vlakno cave, layer 32, early Epigravettian.* Blade artifacts document exploitation mainly of eastern
1124 Adriatic chert, but also use of chert originating from Umbria-Marche Apennine and Venetian
1125 Prealps (Perhoč, 2020) (Tab. 4, Fig. 9d).

1126 *Zala cave, layers 97, 98, 100, 101 and 102, late Epigravettian.* All the artifacts were made using
1127 exogenous materials, given the nearest source positioned 30 km from the site along the gravelly bed
1128 of the Kupa River south of the town of Ozalj. Provisioning area extends south-east in the Lika
1129 region and northern Dalmatia, and west of Istria and more far to the Veneto Prealps. The latter
1130 source supplied half of the artifacts (Perhoč, 2020; Vukosavljević et al., 2015) (Tab. 4, Fig. 9d).

1131 FIGURE 11 ABOUT HERE

1132

1133 **Marche-Abruzzi Apennine**

1134 *Fonte delle Mattinate, layer SU B27, early Gravettian.* The exploited cherts are from the Umbria-
1135 Marche Scaglia Rossa and Scaglia Variegata, outcropping near the site, but also a coarse-textured
1136 gray chert (Oligocene-Miocene flysch improperly called ftanite) not cropping locally, possibly
1137 collected in the Tiber basin or in a northern area along the Apennine range where the Cervarola-
1138 Falterona Unit outcrops (Silvestrini et al., 2005a) (Tab. 4, Fig. 9a). This exogenous arenitic chert
1139 was used to produce a point.

1140 *Ponte di Pietra, layer SU 53-64, late Gravettian.* The exploited cherts totally consist of the Umbria-
1141 Marche Scaglia Rossa and Scaglia Variegata, outcropping near the site, but also different types of

1142 Maiolica not cropping locally, possibly collected along the Misa stream gravel bed (De Stefani et
1143 al., 2005) (Tab. 4, Fig. 9b and 9c).

1144 *Fosso Mergaoni, late Gravettian*. Cherts were collected few kilometers away from stream beds and
1145 slope waste deposits in proximity of primary outcrops of Tertiary and Jurassic formations. The best
1146 represented are Tertiary cherts of Maiolica, Scaglia Rossa and Scaglia Variegata provisioned as
1147 large nodules and slabs (Cancellieri, 2015) (Tab. 4, Fig. 9c).

1148 *Madonna dell'Ospedale, early Epigravettian*. No detailed data on the attribution of the raw material
1149 units are available for the predominant blade and bladelet industry of this site. Its position on an
1150 alluvial terrace along the left slope of a stream valley which dissects Cretaceous marly limestones
1151 (Maiolica and Scaglia) points in favour of local collecting of chert nodules and slabs (Silvestrini et
1152 al., 2008) (Tab. 4).

1153 *Baracche, late Epigravettian*. Similarly to the previous, the blade and bladelet industry of this site
1154 has been macroscopically subdivided in raw material units, but no detailed studies have been done.
1155 Anyway, the exploitation of the local Maiolica and Scaglia cherts is very likely (Peresani et al.,
1156 2005) (Tab. 4, Fig. 9d).

1157 *Campo delle Piane CDP 7, Late Epigravettian*. The lithic assemblage found in layer 24 is made of
1158 Scaglia Rossa and Maiolica cherts provisioned in local gravel deposits and also in primary outcrops
1159 in the surroundings at least 5 km to the west, in the Gran Sasso Massif (Olive, 2017) (Tab. 4, Fig.
1160 9d).

1161

1162 **5. Collected on the sea shore: an overview on the circulation of marine shells beads**

1163 Perforated marine shells were found at Ponte di Pietra and Riparo Tagliente, the only sites on the
1164 western Adriatic that yielded gastropods and bivalves. The commonest species used during the
1165 Gravettian is *Homalopoma sanguineum*, an herbivorous gastropod associated with sea grassland
1166 (es: *Posidonia*) and rocky seabeds and distributed in the Mediterranean Sea from the intertidal belt
1167 to 50 m of depth. Currently, it lives in a variety of pericoastal environments in the lower Adriatic,
1168 Ionian and Tyrrhenian Sea. It is the only species found at Ponte di Pietra, with nine specimens, all
1169 perforated (Gurioli, 2005). Since the Uluzzian, but mostly in the Protoaurignacian, *H. sanguineum*
1170 is a shared cultural-symbolic element in Southern Europe and also in the GAPR as observed at
1171 Grotta Fumane (Peresani et al., 2019). This bright red colored appealing shell was selected for
1172 ornamental purpose also thanks to its morphology and size, as observed throughout most of the
1173 Upper Palaeolithic in a vast area extending from the south-west of Europe to the Eastern

1174 Mediterranean, up to the middle course of the Rhine River (Bosinski, 1999), and to the east of the
1175 Carpatians (Alvarez-Fernández, 2006; Vanhaeren and D’Errico, 2006; Morales et al., 2019; Perlès,
1176 2018; Nițu et al., 2019). Its use has been recorded on the Tyrrhenian side at Riparo Mochi (Stiner
1177 1999), Grotta di Castelcivita (Tassoni, 2019), Grotta La Cala (Tassoni, 2019) and Grotta Serratura
1178 (Martini et al., 2003) and along the eastern side of the Italian Peninsula at Grotta Cavallo (Arrighi et
1179 al., 2020). The *Homalopoma* specimens found at Ponte di Pietra testify the use of this gastropod at
1180 the end of the Gravettian. The thickness of the shell wall may have also been an important feature,
1181 as personal ornaments made of thicker shells might require greater manufacturing skills and time.

1182 The use of this species’ shell decreases considerably during the Late Epigravettian, being replaced
1183 by *Tritia* sp. and *Columbella rustica* as the main ornamental components (Cristiani et al., 2014;
1184 Martini et al., 2003; Perlès, 2018). The oldest settlement phase of the Late Epigravettian
1185 stratigraphic series of Riparo Tagliente (SUs 13a alpha, 13a beta and 300) shows a complex
1186 composition of the ornamental shell assemblage. The dominating shell is *Tritia* (more than 90%)
1187 with prevailing *T. neritea* followed by *T. pellucida*. All other species are either represented by few
1188 specimens each (*Dentalium cf. inaequicostatum*, *H. sanguineum*, *Nassarius cf. pygmeus*) or by just
1189 by one item (*Aporrhais pespelecani*, cf. *Neverita josephinia*, *Gastropoda* indet., *Glycymeris* sp.,
1190 *Nassarius costulatus cuvierii*).

1191 A shell beads assemblage was also discovered in the late Upper Palaeolithic layers of Zala, dated to
1192 the end of LGM. The assemblage consists of 15 marine *Cyclope neritea* perforated shells. A
1193 fragment of *Pecten jacobaeus* shell provides additional evidence for contacts between LGM coast
1194 and the inland where Zala is located (Vukosavljević and Karavanić, 2015).

1195 A variety of hard animal materials has been deliberately modified to shape beads. However,
1196 investigations on these findings are still at an embryonic state, even long after their discovery. This
1197 is especially the case of the seven atrophic red deer canines associated to Gravettian lithics at Grotta
1198 Broion (Leonardi and Broglio, 1960). Aside deliberate polishing and perforations, at present there is
1199 no further information on these teeth, as regarding the manufacture techniques or the possible use of
1200 additional substances such as ochre and other residues. Two modified teeth of *Cervus elaphus* were
1201 found in Šandalja layer C/d (Cvitkušić, 2017).

1202

1203 **6. Discussion**

1204 **6.1. Human groups across the Great Adriatic–Po Plain: a questioned scenario**

1205 The ensemble of evidence illustrated in the previous chapters points to the GAPR as a suitable land
1206 for Gravettian and Epigravettian hunter-gatherers. The view that the mountain ranges and their
1207 forelands around the GPP could have provided profitable habitats for the subsistence of human
1208 populations was questioned several times since the end of the 80's of the 20th century. A major
1209 point of discussion regards the role played by the plain in facilitating the seasonal aggregation of
1210 bands from both sides of the sea. According to Mussi (1990), the gap in the early Gravettian
1211 archaeological record of Italy and the gradual disappearance of items like funerary goods or mobile
1212 art bringing complex symbolic significance observed up to the end of the Gravettian should be
1213 related to slackening in the social relations established among human groups, presumably correlated
1214 to the general decrease in population density. Southern Europe did not escape the consequent
1215 disruption of networks and disappearance of long-range social relationships. Isolated by the
1216 glaciated Alps, the GAPR was connected to the sparsely inhabited western Balkans, sporadically
1217 exploited by small groups. Mussi (1990) suggests, in disagreement to a more consistent evidence of
1218 repeated human frequentations at the multilayered sites distributed along the Tyrrhenian belt and in
1219 the southernmost area of the peninsula, that the GAPR flatland was an arid and steppe-like
1220 environment delimited by instable shorelines and denudated landscapes at the foot of the mountain
1221 ranges. According to this Author, the GAPR was not settled permanently because of hostile climatic
1222 and environmental conditions and too sparse resources to sustain movements of people (Mussi,
1223 2001). The Karst, at the north-eastern edge of the VFP and AP was also considered to be an
1224 inhospitable land during the LG, unforested and generally poor in vegetation, because of its
1225 dryness (Boschian and Fusco, 2007).

1226 Contrasting positions supported at times the view that the plain was rich in game, water and a
1227 variety of resources, especially along the water courses, across ecotones, around the lakes and on
1228 the coastal and estuarine environments, and thus attractive for human populations (Van Andel,
1229 1989; Shackleton et al., 1984; Bailey and Gamble, 1990). Based on archaeofaunal data from Istria
1230 and the Kvarner region (Miracle, 1994-1995, 2007), conceives this vast land as seasonally crossed
1231 by large migratory game. He arguments that all this game is representative of a rich and diverse
1232 mammal biome exploited by humans at the margins of the eastern AP and that the karstic inland
1233 was sporadically settled on a strictly seasonal basis and careful planning (Miracle, 1994-95).

1234

1235 **6.2. Great Po Plain and Great Adriatic-Po Region ecological conditions and sustainability**
1236 **during the LGM**

1237 As highlighted above, previous ideas about the sustainability of the GAPR for hunter-gatherers are
1238 somewhat conflicting. Hereafter, we examine the GAPR ecological pattern in view of the spatial
1239 diversity of environmental resources in the LGM. Besides, we discuss the effects of the
1240 environmental changes intervening in the LG.

1241 In spite of the semiarid land expansion in the GARP lowlands during the late MIS 3 and MIS 2 cold
1242 phases (Badino et al., 2020), meltwater discharge provided an extra-contribution to water resource
1243 available to the lowland ecosystems. Here, edaphic moisture stored by fine-grained sediments and
1244 reduced evapotranspiration triggered the development of wetlands (see Tab. 1, Fig. 2). A striking
1245 mosaic with contrasting treeless shrubby semidesert and short-grass steppes with highly productive
1246 mires is envisaged for the lower megafan belt (around -20 to +100 m amsl). Water resources were
1247 enhanced by summer snow and ice melting implying increased biomass production and hunting
1248 potential during summertime. However, in the lowstand AP, the availability of surface water and
1249 soil water regimes are debatable, due to uncertainties in reconstructing the hydrographic network
1250 (Fig. 2, see section 2.1) and, most important, the watertable levels.

1251 The ecogradient linking the higher, coarse-grained megafans belt with the Alpine piedmont and the
1252 mountains can be traced thanks to the palaeoecological record (sections 2.1 and 2.2.) and,
1253 remarkably, by consistent indications for modern ecological analogues in the mountain-piedmont
1254 systems of Central Asia (see Tab. 1, Fig. 4, and references herein). Several biomes existed along
1255 this ecoclimate elevational gradient, compressed in a space of a few tens of kilometers - from short
1256 grass steppes supporting a rich megafauna, to boreal forests with its resources; to alpine grasslands
1257 supporting ungulates; to cold rocky semideserts. Additionally, eco- and biodiversity were increased
1258 by bedrock variability, especially the extensive denudated limestone lands widespread in the GAPR.
1259 All these phenomena during the LGM triggered habitat diversification, along with karstic
1260 conservative habitats and stable climatic microrefugia (Dobrowsky, 2011). These contexts in the
1261 GPP sustained herbivores population, largely composed by the steppe bison (*Bison priscus*),
1262 alongside with moose (*Alces alces*) and, possibly auroch (*Bos primigenius*). The ecology of the
1263 steppe bison, as inferred from fossil evidence and through comparison with living relatives, the
1264 American bison (*Bison bison*) and the European bison or wisent (*Bison bonasus*) points to a grazer
1265 of wooded steppe mosaics (for the American bison), while wisents were present in a more diverse
1266 environment and adopted a more variable diet (Brugal et al., 1999; Kerley et al., 2012; Bocherens et
1267 al., 2015; Soubrier et al., 2016). *B. priscus* diet included grass from typical steppe and grassland
1268 (C3) including lichens in eastern Ukraine 18.5 ka cal BP (Julien et al., 2012), partly complemented
1269 by woody plant as also inferred from frozen remains dated 36 ka cal BP in Alaska (Guthrie, 1990).

1270 Comparably to *B. bison* and *B. bonasus*, Late Pleistocene bisons were gregarious, the size and
1271 structure of the herds varying in function of the seasonally available resources (Plumb et al., 2009;
1272 Krasinska and Krasinski, 2013). Although sparse, zooarchaeological data point to consider these
1273 large herbivores as a targeted game for Gravettian and Epigravettian hunters.

1274 The limestone Berici Hills (Fig. 2 for location) may serve as an example. Here, fossil pollen records
1275 from caves and shelters document rocky steppe and semideserts already in Late MIS 3, but
1276 expanding during the latest MIS 3 and LGM (Cattani and Renault-Miskovsky, 1983; Bartolomei et
1277 al., 1985; Pini, unpublished pollen spectra). Downhills, the Berici were fringed by boreal forests
1278 and wetlands throughout the LGM, although their extension was subject to submillennial climate
1279 variability (Pini et al., 2010; Badino et al., 2020; submitted). The Berici hills could be envisaged as
1280 a condensed segment of the Alpine-piedmont ecogradient (see above) including a dry extreme of
1281 karstic rocky steppe with ibex, a foothills forest belt (with giant deer and deer) and a wetland
1282 mosaic in the plains. This latter ecozone represented an auroch and moose hunting for Late
1283 Mousterian up to Gravettian groups (Terlato et al., 2019b; Romandini and Nannini, 2012) and a
1284 foraging area for the cave bear (Terlato et al., 2019a). This ecogradient was condensed in a linear
1285 space from 1 to 5 km. Paleolithic hunter-gatherers dwelled this area throughout the LGM, also in
1286 reason of caves availability (see sect. 3.3).

1287 It would be misleading to claim the Karst itself as a desolated land. Its proximity to high mountains
1288 promoted ecodiversity and enhanced resources. Water resources were provided by hypogean
1289 watercourses and springs fed by the melting of glaciers in the Julian Alps and Dinarides. An
1290 additional input of orographic climate moisture is testified by the persistence of boreal forest at the
1291 foothills of Alps-Dinarides junction during all the LGM (Monegato et al., 2015). Indeed, as testified
1292 at Abri Kontija 002, Istria was repeatedly settled during the Gravettian (Janković et al., 2015).

1293

1294 **6.3. Impact of vegetation changes intervening at the Late Glacial onset**

1295 An important challenge for the history of human-environment interaction in GAPR are the rapidly
1296 changing conditions developed since the LGM / LG transition which is chronologically constrained
1297 at 18/17.5 ka cal BP south of the Alps (Ravazzi et al., 2007; Vescovi et al., 2007; Finsinger et al.,
1298 2008; Wirsig et al., 2016), slightly anticipating the collapse of the ice-sheets (the end of the LGM
1299 according to Lambeck et al., 2014). At the Alpine foothills, a forest progression started immediately
1300 with increasing insolation, so that trees witnessed the glacier collapse just after 17.5 ka cal BP
1301 (Kromer et al., 1998; Ravazzi et al., 2014; Monegato and Ravazzi, 2018). In about a thousand years,
1302 formerly glaciated forelands experienced a rapid vegetation chronosequence from glacial desert to

1303 pine-larch woodlands. However, forest progression in elevation was initially limited and only
1304 reached over 1500 m amsl after the onset of the LG interstadial (Gehrig, 1997; Heiss et al., 2005).
1305 Furthermore, summer drought limited forest progression over steppic hills and sunny slopes, and, in
1306 connection with increased fuel availability, enhanced fire propagation and frequency. During the
1307 early LG, even in the distal sector of the megafans, fluvial activity of the main Alpine rivers was
1308 limited to the incised valleys, thus maintaining open dynamic vegetations such as shrubby
1309 semideserts. Being these landscapes inhabited by bisons and other large herbivores hunters, we
1310 cannot exclude that Gravettian and early Epigravettian human groups might have targeted bison
1311 herds on a seasonal base, similarly to Neanderthals (Terlato et al., 2019b). Unfortunately, there are
1312 no migratory-related ethological data about bisons in the GAPR. Taking as a reference the
1313 European bison leaving in the forest-field landscape in Poland, no historical data are known on its
1314 seasonal movements, despite altitudinal shifts in mountain areas are not excluded (Krasinska and
1315 Krasinski, 2013). Taking as a close reference the American plains, bisons forage on open
1316 bottomlands and lower adjacent slopes and may seasonally move until as much as 250 km, also in
1317 crossing forest areas and steep slopes (Meagher, 1989). By reference to historical ethnographic and
1318 ecological data from Northamerican natives (Roos et al., 2018), it cannot be excluded that
1319 Gravettian and early Epigravettian hunting strategies had an impact on fire regimes.

1320

1321 **6.4. Hunter-gatherers in the Great Adriatic-Po Region: rhythms and circulation**

1322 During the the LGM and early LG, European hunter-gatherers inhabited with variable continuity
1323 cold, cold-temperate and often moister biomes. The western regions of the continent are estimated
1324 to have represented the most settled area (Tallavaara et al., 2015; Burke et al., 2017), traditionally
1325 considered a cradle of remarkable cultural changes following the Gravettian in comparison to the
1326 patchy settlement scenario currently known from central-eastern Europe. However, of the huge
1327 amount of archaeological evidence recorded between the Rhine and the Volga, the most striking
1328 points to long distances covered by the circulation of chert and other stones used to manufacture
1329 domestic tools, hunting implements and mobile art artifacts. Petroarchaeological cases examined by
1330 Féblot-Augustins (1997) in her seminal study, record distances up to 160 km of provenance for
1331 lithic artifacts recovered at Dolní Vestonice and Pavlov in Moravia and in the Váh river valley and
1332 even up to 300 km in eastern Slovakia, the Svabian Jura and Rhenania (Scheer, 2000). Raw blocks,
1333 prepared cores and other artifacts were interpreted as an expression of embedded provisionings of
1334 cherts made by groups or individuals during their seasonal yearly circulation, as supposed for
1335 certain items in Pavlov and in other sites in Moravia positioned along the main river courses (Oliva,

1336 2000). Longer-distance social networks encompass the 450 km recorded in lower Austria, with
1337 obsidian provisioned in the Carpathian mountain range (Féblot-Augustins, 1997; Dobosi, 2000) or
1338 the perforated *Homalopoma sanguineum* ornamental shells brought at Poiana Cireşului (northern
1339 Carpatians), over 900 km of distance from the sea (Nițu et al., 2019).

1340 Regarding the GAPR, connections between sites located over 250 km apart from another do not
1341 contradict the scenario drawn in the innermost continental Europe. Our petroarchaeological
1342 evidence confirms that the GPP was systematically crossed by the Gravettians and the early
1343 Epigravettians. Stable terraces along the Apennine belt were potential areas to settle on a seasonal
1344 base or maintain a network of exchanges between different groups. The same holds for the wide
1345 alluvial plain with its main river courses, alluvial terraces and sand dunes. Despite the absence of
1346 direct evidence, we cannot deny that the suitability of these riverine environments could have
1347 favoured the installation of residential camps. Another land suitable for settling was the northern
1348 Adriatic Sea shore and the Po River delta, thanks to its environmental variability and the direct
1349 connection to Dalmatia.

1350 Although data about human mobility during the Middle (Evolved) Gravettian are too sparse in the
1351 GAPR to reconstruct the settlement dynamics in this landscape, a marked trend can be highlighted
1352 starting with the Late (Final) Gravettian early Epigravettian and up to the early Late Epigravettian.
1353 This event coincides with a renewal in hunting weaponry around 24 ka cal BP, mainly consisting in
1354 the introduction of shouldered points rather than other backed implements. The long-range
1355 circulation of these points encompasses several macro-regions of Europe and could be related to
1356 new mobility strategies or changes in human groups and their way of exploiting resources in this
1357 territory. Furthermore, too poor or biased archaeological contexts do not support enough
1358 assessments on the possibility that the Gravettian to early Epigravettian techno and socio-economic
1359 changes were accompanied by profound renewals in ornamental sets. Not enough evidence is in fact
1360 currently available in the sites of the GAPR, for examining the relations between the Gravettian and
1361 its shared use of beads made of perforated *H. sanguineum* shells all over southern Europe and the
1362 following culture. The early Epigravettian replaced the former around 24 ka cal BP, broadly in
1363 coincidence of the GI-2, a climatic threshold marking major cultural changes in western Eurasia.
1364 Extensive renewals in the variety of marine species used as ornaments are recorded only during the
1365 Late Epigravettian, hence leaving uncertainty on a wide chronological range.

1366 Therefore, further chronological assessments are required to refine the timing of the Gravettian -
1367 early Gravettian replacement and correlate it to the major ecological turnovers in the GAPR.
1368 Traditionally, the large-scale circulation of different categories of items is likely to be considered

1369 one of the most reliable indicators to explain the emplacement of the post-Gravettian cultural
1370 mosaic in Europe, a vast ethno-geographic phenomena leading to the rapid spread of the Solutrean,
1371 Badegoulian, Magdalenian and other complexes in the western Atlantic regions and the
1372 Epigravettian in Mediterranean France, the Italian peninsula, the Balkan area and towards the East.
1373 Long-range mobility in the GPR is clearly attested by the tracing of fine-quality cherts used to
1374 manufacture shouldered points or to maintain the provisioning of individuals through the circulation
1375 of cores or semi-finished products from the Apennines to hunting camps and short-term settlements
1376 on the opposite side of the GPR, but also reversely from the Eastern Prealpine belt to caves in
1377 northern Dalmatia. Caves and rockshelters positioned in proximity of the ecotones or in other
1378 contexts characterized by environmental variability supported the peopling of the GPR on a
1379 seasonal base. Currently, evidence is not available to ascertain whether the alluvial megafans of the
1380 northern PP and of the VFP were settled. Although the continuous sedimentary aggradation made
1381 these large elements of the GPR landscape unsuitable to settle on unstable surfaces, we cannot deny
1382 that particular environments, such as the spring belts could have been considered worthy of placing
1383 the camps on the base of their ecological attractiveness.

1384 A second major turnover in settlement dynamics in the GPR relates to the end of the LGM and the
1385 corresponding collapse after 18 ka cal BP of the Alpine glaciers, starting their final withdrawal and
1386 triggering the fluvial incision of the fans and megafans of PP and VFP. The largest portion of these
1387 landforms became free of floods and stable, while the development of active riverine environments
1388 and new wetlands was limited along the incised valleys cutting the plain and the groundwater-fed
1389 rivers. Such quick geomorphological changes are expected to have produced effects on human
1390 occupation, however not yet detected, along the river terraces in the plain. In the Prealpine foothills,
1391 Riparo Tagliente is a location persistently settled by human groups for the exploitation of the local
1392 biotic and abiotic resources which marks one of the first steps of the pioneering exploitation of the
1393 inner Prealpine belt on relatively stable areas. However, evidence of this phase is still very limited
1394 and such scarcity of data hampers the reconstruction of the peopling of the Italian Eastern Alps and
1395 the Dinarides triggered by the climatic amelioration of the LG interstadial starting at 14.7/14.5 ka
1396 cal BP. In the LG interstadial, the progressive rise of the Adriatic coastline combined to the
1397 expansion of the treeline up to 1700-1800 m amsl in the SE-Alps (Ravazzi et al., 2007) are among
1398 the key factors leading human groups to intensely occupy the interior mountain ranges along new
1399 routes and to expand their settlements (Bertola et al., 2007; Naudinot et al., 2014).

1400

1401 **6.5. Human groups across continental shelves and bridges: comparing the Great Adriatic-Po**
1402 **Region**

1403 The emergence of the continental shelves around the European continent as a consequence of the
1404 LGM lowering of the sea level, profoundly changed its geography, especially off the present-day
1405 low coastal belts (Fig. 1). This process exerted the highest magnitude both in the southern and
1406 northern latitudes, as along the Channel, the North Sea, the Atlantic western and northern coast of
1407 France, the North Black Sea and other smaller traits along the Mediterranean and Atlantic littorals.
1408 Climate-ecological modelling predicts that some of these extreme landscapes, close to the ice
1409 sheets, were left uninhabited (Tallavaara et al., 2015; Burke et al., 2017). This was the case of the
1410 338,000 km² vast land of western and northern Europe that emerged as a consequence of the retreat
1411 of the Channel and the North Sea. This flat region connecting the British Islands with the continent
1412 was wind-lashed and unsuitable for human settlements roughly since the onset of the LGM
1413 (Roebroeks, 2000, but see Jacobi and Higham, 2008), until the gradual warming phase at 19-17.5 ka
1414 cal BP, when population started to expand northward from the core areas in southwest and central
1415 France. The two ephemeral exceptions being the late Gravettian frequentation at Renancourt 1 (60
1416 km south-east of the present-day Channel coast - Paris et al., 2017) and the Solutrean frequentation
1417 in the southern part of the Paris Basin (Bodu et al., 2019). Oisy and Grotte du Renne, France, testify
1418 to more reliable frequentations at 47.5° N than sites in Normandy, Pas-de-Calais, and during H1 in
1419 England, Germany and Belgium (Miller, 2012). Magdalenian northern expansion towards the north
1420 European plain began during the fairly rapid increase in temperature started 16.5 ka cal BP. The
1421 first hunter-gatherers occupations occurred in the Paris Basin and in Belgium; then England was
1422 settled 14.7-14.1 ka cal BP during GI-1e, to be extensively occupied during the Bølling (Otte, 1990;
1423 Gamble et al., 2006; Miller, 2012). Fluvial systems with river channels, plains, wetlands and
1424 estuaries would have exerted an attractive force on prehistoric hunter-gatherers (Gupta et al., 2008;
1425 Momber et al., 2016).

1426 The shelf emerged off the Atlantic coast of France was another vast land inhabitable during the
1427 LGM and connected to the north with the Channel shelf (Farr et al., 2017). No evidence suggests
1428 the frequentation of this 55,000 km² large land from the coast of Aquitaine up to the Molène
1429 archipelago. Aside the biases due to surveying constraints in the submarine landscape, this gap
1430 could be partly related to the environmental conditions in the Landes region. Here, the sand cover
1431 extended so much into the hinterland to make conditions inhospitable for human settlement and
1432 favouring the persistence of a cultural barrier between Pyrenees - Cantabria and Charente - Périgord
1433 (Bertran et al., 2013) through all the Gravettian, Solutrean and part of the Magdalenian. Given the

1434 peopling of both these regions south and north of this deserted area, it has been suggested that
1435 hunter-gatherers circulated along the coastline of the submerged shelf (Billard et al., 2020).

1436 Large regions remained uninhabited also at more southern latitudes, as in the case of the Great
1437 North Black Sea region. This 122,000 km² large flat landscape included the coastal lowland, the
1438 lower Dniester, Dnieper and Don alluvial plains expanded over 200 km to the south during the
1439 LGM lowering, when the Black Sea turned its water composition to brackish and saline lake as a
1440 consequence of being isolated from the Sea of Marmara and the Mediterranean by the Bosphorus
1441 sill (Kaplin and Selivanov, 2004). The Crimea, the rim of the Azov Sea and the north-western
1442 Russian Caucasus belonged to this region. The dominant biomes, the periglacial steppe and the
1443 grass-herb steppe in the southernmost belt (Velichko and Zelikson, 2005) were not attractive for the
1444 Gravettian hunter-gatherers, adapted to the northern periglacial steppe zone with permafrost and
1445 mammoths. The general decline in population of Central Europe during H2 (Maier and
1446 Zimmermann, 2017) also explains human absence in the Great North Black Sea region until 25 ka
1447 cal BP, when Epi-Aurignacians settled the western part of Ukraine and the plains east of the Azov
1448 Sea for few thousands years until 23 ka cal BP, hunting bisons, but still leaving uninhabited the
1449 southernmost areas of the region. Predictive models have been proposed for testing the expectation
1450 of finding submerged Late Palaeolithic settlements in the watershed plateau, river terraces and
1451 slopes, river valleys and hills around the Dniester-Kuyalnik interfluvium (Kadurin et al., 2020), far
1452 from the marshy lowmarine coast. Starting from 23 ka cal BP, the early Epigravettians populated
1453 the steppic region basing their subsistence on the hunting of bisons (Demidenko, 2008) and
1454 extended their presence in south-eastern Europe.

1455 In the western Mediterranean, the southern shifting of the coast in the Gulf of Lyon originated a
1456 12,000 km² land mass used as a transition corridor by bearers of the Solutrean, Salpêtrian and
1457 Middle Magdalenian cultural complexes. Evidence ascribed to the human presence in proximity of
1458 this corridor is represented by the extraordinary paintings dated to the Gravettian and Epigravettian
1459 in the partly submerged Cosquer cave on the Marseilles Calanques, at the eastern edge of this
1460 continental shelf (Valladas et al., 2017). Decorations include seals, auks, fishes and jellyfish.
1461 Further indirect evidence of the exploitation of the marine shore resources is recorded through
1462 shells used as beads at inland Middle Magdalenian sites (Bazile, 1997).

1463 Due to the dominant extension of its steep coasts, the Iberian Peninsula increased its extension
1464 limitedly to the middle Mediterranean zone in the Valencia gulf up to the Ebro Delta. Data on
1465 human subsistence remain however too scanty to infer models on mobility and subsistence of the
1466 Solutrean groups who settled this margin extended over 17,500 km² and are limited to record no

1467 evidence of marine resources in inland sites, compared to the increasing number of evidence of
1468 marine fishery in the LG (Aura Tortosa et al., 2019).

1469 Also, the western border of southern Iberia extended far into the ocean. The region concerned was
1470 the Estremadura, bordered by the Tagus and Mondego rivers and by mountain ranges peacking at
1471 2000 m, to the east. The total land extended over 12,000 km² where the 60% was the littoral shelf
1472 (Zilhão, 1997). This land mass sustained Solutrean groups who established their territories along the
1473 main river courses and hunted red-deer, horse and wild boar. Human groups settled in caves and
1474 open-air sites, with caves used as temporary and specialized shelters for small groups of hunters. On
1475 the contrary, several open-air locations provide so high amount of evidence to infer continuous
1476 residential settling also supported by the proximity to sources of provisionable chert. Although
1477 biased by unextensive surveying, the absence of base-camps from the present-day coastal area
1478 suggests that the submerged littorals with their estuarine and coastal aquatic resources as much as
1479 the inland garrigues, were at the edges of the settled landscape (Zilhão, 1997). Considered all
1480 together, these lands supported a productive Solutrean unit of estimated 500 individuals with a
1481 relatively stable ethnic entity but open to social and cultural relations with the rest of Iberia.

1482 Given the multidisciplinary and petroarchaeological data illustrated in this chapter and in the
1483 chapters above, the GAPR supports comparison with the largest LGM continental shelves of Europe
1484 but differentiates from these due to the presence of palaeontological and archaeological sites
1485 scattered on its sides. This particular morphological structure makes possible to track movements
1486 from on side to another across lowlands or along the coastal belt, an opportunity, which is precluded
1487 in others geographic areas.

1488

1489 **6.6. Demography and turnovers inferred from ancient human DNA**

1490 Palaeogenetic studies focusing on hunter-gatherer individuals revealed that several population
1491 transformations took place across Palaeolithic and Mesolithic Europe (Fu et al., 2016; Posth et al.,
1492 2016). Previous analyses of mitochondrial DNA (mtDNA) genomes have shown that, while some
1493 of the pre-existing mtDNA diversity was lost during the LGM, most of the European maternal gene
1494 pool survived this severe population bottleneck. However, a population turnover was observed
1495 through a sharp shift in mtDNA haplogroup frequencies around 14.5 ka cal BP, coinciding in time
1496 with the Bølling/Allerød (Posth et al., 2016). Nuclear DNA analyses later demonstrated that this
1497 genetic discontinuity was due to the spread of individuals sharing distinctive affinity to present-day
1498 populations from the Near East. This incoming genetic component largely replaced the ancestry
1499 identified in older Magdalenian-related individuals from central Europe (Fu et al., 2016). The oldest

1500 genome harbouring the Near Eastern link is Villabruna, an Epigravettian individual retrieved in
1501 Riparo Villabruna, Veneto Prealps and dated to 14.2-13.8 ka cal BP (Aimar et al., 1992; Vercellotti
1502 et al., 2008). Two demographic scenarios were proposed to explain the expansion of the Villabruna-
1503 related genetic cluster, and involved either (1) a long-range migration from the Near East to Europe,
1504 which took place at least 6 ka years before the Neolithic farming expansion, or (2) a double genetic
1505 dispersal of a southern European population, both towards the east and the west, which was
1506 responsible for drawing these distinct ancestries together.

1507 Mesolithic individuals from the Iron Gates region in Serbia and Romania showed evidence of
1508 interaction with Near Eastern populations, as some of them carried mtDNA haplogroups that are
1509 most prevalent in ancient and contemporary individuals from the Near East (Mathieson et al.,
1510 2018). However, recent genomic analyses of a 15ky old individual from central Anatolia suggested
1511 that the Iron Gates group did not simply derived from a unidirectional gene flow from Near Eastern
1512 to European hunter-gatherers. On the contrary, an additional genetic influx from populations
1513 ancestral to southern Europeans into the Near East has been proposed (Feldman et al., 2019).

1514 Ancient human DNA data of individuals older than 14 ka cal BP is still missing from the Balkans
1515 and the GAPR impeding a genetic characterization of the groups living in this area during the
1516 Gravettian and early Epigravettian. Nevertheless, described genetic contacts with groups from
1517 southwestern European fringes might provide an indirect evidence for the presence of the
1518 Villabruna-related component in southern Europe well before the Bølling/Allerød. In fact, it has
1519 been recently shown that the genetic make-up of hunter-gatherers from Iberia dated after ~19 ka cal
1520 BP was formed through the admixture of two divergent ancestries. One ancestry was associated
1521 with Magdalenian individuals older than 15 ka cal BP and the other with members of the
1522 Villabruna-related cluster, so far only younger than 14 ka cal BP. Interestingly, the oldest
1523 representative of the Magdalenian-related cluster, dated to around 18.6 ka cal BP from El Miron
1524 cave in Spain, was found to be substantially admixed with a group related to the Villabruna
1525 individual (Villalba-Mouco et al., 2019). This suggests the arrival of the Villabruna-related genetic
1526 component in Iberia before 14 ka cal BP, implying that this cluster was widespread in southern
1527 Europe several thousands of years before the age of its oldest genome described until now.

1528 Taken together, these palaeogenetic results support the idea that, from at least 19 ka cal BP,
1529 southern European populations were broadly interconnected across the GAPR and beyond.

1530 Additional genome-wide data of individuals older than 14 ka cal BP from this region is essential to
1531 understand the distribution of such ancestry through time in southern European climatic refugia.

1532 This will allow a better comprehension of the population dynamics that accompanied modern
1533 human re-expansion into Europe towards the end of the coldest period of the LGM.

1534

1535 **7. Conclusions**

1536 The Great Po Plain is the largest alluvial plain ever existed in the Mediterranean basin since the
1537 onset of the Middle Pleistocene, and expanded to reach its maximum size in the LGM. Meanwhile it
1538 greatly pulsated with glacial cycles, pacing the high magnitude sea-level changes related to land ice
1539 mass size. This land hosted human groups, surviving during the LGM and settling their camps in
1540 different ecological contexts, ranging from the Alpine vegetation to the Alpine timberline, down to
1541 low-elevational open boreal forest and finally to semiarid ecotones below the continental
1542 timberline. Semiarid ecozones developed especially in the Alpine foreland and in the Adriatic plain.
1543 Fauna impoverished in consequence of gradual disappearance of mammoth, woolly rhino and giant
1544 deer, together with cave bear, a species targeted by the Epigravettian hunters. The steppe bison was
1545 the most iconic herbivorous species in the plain and together with ibex in the lower hilly landscapes
1546 of the GAPR.

1547 Unexpected archaeological evidence dated to GS-5 on the watershed of the northern Apennine
1548 range also indicates that open, extreme landscapes were the edge of elevational logistical
1549 movements of human groups along mountain ecozones. Despite the sparseness of the
1550 archaeological record with its uneven distribution of sites and the relatively limited evidence of
1551 human presence, the GPP seems to have been crossed and inhabited all along the LGM from the
1552 early Gravettian to the first part of the late Epigravettian. This has been clearly established through
1553 the circulation of finished or semifinished early Epigravettian artefacts made of chert coming from
1554 the formations of the Umbria-Marche Apennines in the subalpine zone, Istria and Dalmatia. Given
1555 the functional nature of the most extensively investigated sites, it can be inferred that provisioning
1556 of chert was not embedded in a broad strategy of resource acquisition but, rather, was the outcome
1557 of specialized planned activities. These activities were likely within the framework of seasonal
1558 displacement and aggregation of groups in settlements, the existence of which can only be supposed
1559 given the inaccessibility of the submerged plain. It is reasonable to think that the wide open spaces
1560 of the GAPR favoured a great mobility of human groups in the framework of a cultural identity
1561 extending into southern Europe.

1562 The Alpine Late Glacial onset was a turning point for bio-geographic evolution also in this area
1563 marked by the loss of large continental plains, thus implying an overall rearrangement of all
1564 ecozones of human populations, and air mass circulation patterns, triggering phylogeographic

1565 bottlenecks. As a consequence of the Late Glacial interstadial warming, a large-scale Epigravettian
1566 colonization of the Alps, the Apennine, the Dinarides and other mountain ranges started.

1567

1568

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1579 original petroarchaeological data, A.F., G.M., P.M., L.R., S.R. and A.Z. geomorphological
1580 framework, C.R., R.P. and G.F. plant ecological framework, M.B. vertebrate palaeontology
1581 framework, M.P., F.F., I.J., I.K. and N.V. cultural framework, S.B., M.P. and Z.P. chert
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1585

1586

1587 **References**

- 1588 Adam, E., 2007. Looking out for the Gravettian in Greece. *Paléo* 19, 145-158.
- 1589 Aimar, A., Alciati, G., Broglio, A., Castelletti, L., Cattani, L., D'Amico, C., Giacobini, G., Maspero,
1590 A., Peresani, M., 1992. Les Abris Villabruna dans la Vallée du Cismon. *Preistoria Alpina* 28, 227-
1591 254.
- 1592 Álvarez-Fernández, E., 2006. Personal ornament made from mollusc shells in Europe during the
1593 Upper Palaeolithic and Mesolithic: new and views. In: Cakirlar, C. (Ed.), *Archaeomalacology*
1594 revisited. Non-dietary use of molluscs in archaeological settings, pp.1-8.
- 1595 Amorosi, A., Fontana, A., Antonioli, F., Primon, S., Bondesan, A., 2008. Post-LGM sedimentation
1596 and Holocene shoreline evolution in the NW Adriatic coastal area. *GeoActa* 7, 41–67.

- 1597 Amorosi, A., Maselli, V., Trincardi, F., 2016. Onshore to offshore anatomy of a late Quaternary
1598 source-to-sink system (Po Plain–Adriatic Sea, Italy). *Earth Sci. Rev.* 153, 212–237.
- 1599 Amorosi, A., Bruno, L., Cleveland, D.M., Morelli, A., Hong, W., 2017. Paleosols and associated
1600 channel-belt sand bodies from a continuously subsiding late Quaternary system (Po Basin, Italy):
1601 New insights into continental sequence stratigraphy. *GSA Bulletin* 129(3-4), 449–463.
- 1602 Antonioli, F., Vai, G.B. (Eds.), 2004, *Litho-Paleoenvironmental Maps of Italy During the Last Two*
1603 *Climatic Extremes*. ENEA.
- 1604 Antonioli, F., Ferranti, L., Fontana, A., Amorosi, A., Bondesan, A., Braitenberg, C., Fontolan, G.,
1605 Furlani, S., Mastronuzzi, G., Monaco, C., Spada, G., Stocchi, P., 2009. Holocene relative sea-level
1606 changes and vertical movements along the Italian and Istrian coastlines. *Quat. Int.* 206, 101–133.
- 1607 Aranguren, B., Revedin, A. (Eds.), 2008. *Bilancino: a 30,000 Years Ago Camp-Site in Mugello,*
1608 *Florence*. Istituto Italiano di Preistoria e Protostoria, Firenze.
- 1609 Arrighi, S., Bortolini, E., Benocci, A., Manganeli, G., Spagnolo, V., Foresi, L., Bambini, A.M.,
1610 Lugli, F., Badino, F., Aureli, D., Boschini, F., Figus, C., Cipriani, A., Romandini, M., Peresani, M.,
1611 Ronchitelli, A., Moroni, A., Benazzi, S., 2020. Backdating systematic shell ornament making in
1612 Europe to 45,000 years ago. *Arch. Anthr. Sci.* doi.org/10.1007/s12520-019-00985-3
- 1613 Auboin, J., 1963. Essai sur la paléogéographie post-triassique et l'évolution secondaire et tertiaire
1614 du versant sud des Alpes orientales (Alpes méridionales; Lombardie et Vénétie, Italie; Slovénie
1615 occidentale, Yougoslavie. *Bull. Soc. Géol. France* V, 730-766.
- 1616 Aura Tortosa, J.E., Marlasca Marin, R., Maestro, A., 2019. Fishes from solutrean sites of the Iberian
1617 Mediterranean Region: palaeogeographical, palaeoecological and techno-economic data. In:
1618 Schmidt, I., Cascalheira, J. (Eds.), *Human adaptations to the Last Glacial Maximum*. Cambridge
1619 Scholars Publishing, pp. 372-394.
- 1620 Badino, F., Pini, R., Ravazzi, C., Margaritora, D., Arrighi, S., Bortolini, E., Figus, C., Giaccio, B.,
1621 Lugli, F., Marciani, G., Monegato, G., Moroni, A., Negrino, F., Oxilia, G., Peresani, M.,
1622 Romandini, M., Ronchitelli, A., Spinapolice, E.E., Zerboni, A., Benazzi, S., 2020. An overview of
1623 Alpine and Mediterranean palaeogeography, terrestrial ecosystems and climate history during MIS
1624 3 with focus on the Middle to Upper Palaeolithic transition. *Quat. Int.* 551, 7-28.
- 1625 Badino, F., Pini, R., Bertuletti, P., Ravazzi, C., Margaritora, D., Delmonte, B., Monegato, G.,
1626 Reimer, P.J., Vallè, F., Maggi, V., Arrighi, S., Bortolini, E., Figus, C., Lugli, F., Marciani, G.,
1627 Oxilia, G., Romandini, M., Silvestrini, S., Benazzi, S., submitted. The fast-acting "pulse" of
1628 Heinrich stadial 3 in a mid-latitude boreal ecosystem: ecoclimatic patterns and fire regimes.
1629 *Scientific Reports*, Submission ID 55a5c790-c084-4239-b416-f2504d0da999

- 1630 Bailey, G., Gamble, C., 1990. The Balkans at 18.000 BP: the view from Epirus. In: Soffer, O.,
1631 Gamble, C. (Eds.), *The world at 18.000 BP*. London: Unwin Hyman Ltd.
- 1632 Barron, E., Pollard, D., 2002. High-resolution climate simulations of Oxygen Isotope Stage 3 in
1633 Europe. *Quat. Res.* 58, 296-309.
- 1634 Bartolomei, G., Broglio, A., Palma Di Cesnola, L., 1977. Chronostratigraphie et écologie de
1635 l'Épigravettien en Italie. In: AA.VV. (Eds.), *La fin des temps glaciaires en Europe -*
1636 *Chronostratigraphie et écologie des cultures du Paléolithique final*. Actes Colloque International
1637 C.N.R.S. 271, pp. 297-234.
- 1638 Bartolomei, G., Broglio, A., Cattani, L., Cremaschi, M., Guerreschi, A., Mantovani, E., Peretto, C.,
1639 Sala, B., 1982, I depositi würmiani del Riparo Tagliente. *Ann. Univ. Ferrara*, n.s. sez. XV, 3, 61-
1640 105.
- 1641 Bartolomei, G., Broglio, A., Cattani, L., Cremaschi, M., Lanzinger M., Guerreschi, A., Mantovani,
1642 E., Peretto, C., Sala, B., 1985. Risultati preliminari delle nuove ricerche nella Grotta di Paina.
1643 *Jagen und Sammeln. Jahrbuch Bernischen Historischen Museums 1983-1984*, 43-54.
- 1644 Bassetti, M., Cavulli, F., 1999. Contributi alle ricerche paleoambientali nel bacino del Palù di
1645 Livenza (margini prealpino friulano). In Vitri S., Visentini P. (Eds.), *Il Palù alle sorgenti del*
1646 *Livenza: Ricerca archeologica e tutela ambientale*. Atti tavola rotonda, Polcenigo 16 aprile 2001.
1647 *Comunità Pedemontana del Livenza, Grafiche Risma*, 103-139.
- 1648 Bazile, A., 1997. Le Languedoc oriental de 20.000 a 12.000 ans avant le present: homme et milieu.
1649 In: Fullola, N., Soler, J.M. (Eds.), *El mon mediterrani deprés del Pleniglacial (18.000-12.000 BP)*.
1650 *Sèrie Monogràfica*, 17, *Museu d'Arqueologia de Catalunya*, Girona, pp. 175-192.
- 1651 Becker, P., Seguinot, J., Jouvet, G., Funk, M., 2016. Last Glacial Maximum precipitation pattern in
1652 the Alps inferred from glacier modelling. *Geogr. Helv.* 71, 173-187.
- 1653 Benjamin, J., Rovere, A., Fontana, A., Furlani, S., Vacchi, M., Inglis, R.H., Galili, E., Antonioli, F.,
1654 Sivan, D., Miko, S., Mourtzas, N., Felja, I., Meredith-Williams, I., Goodman-Tchernov, B.,
1655 Kolaiti, E., Anzidei, M., Gehrels, R., 2017. Late Quaternary sea-level changes and early human
1656 societies in the central and eastern Mediterranean Basin: an interdisciplinary review. *Quat. Int.*
1657 449, 29–57.
- 1658 Berto, C., Luzi, E., Montanari Canini, G., Guerreschi, A., Fontana, F., 2018. Climate and landscape
1659 in Italy during Late Epigravettian. The Late Glacial small mammal sequence of Riparo Tagliente
1660 (Stallavena di Grezzana, Verona, Italy). *Quat. Sci. Rev.* 184, 132-142
- 1661 Bertola, S., 2012. Approccio micropaleontologico discriminante per riconoscere la provenienza
1662 alpina o appenninica delle selci della Scaglia Rossa. *Bull. Mus. Anthr. Préh. Monaco* 52, 17-27.
- 1663 Bertola, S., 2016. Southern Alps (Trento plateau) and Northern Apennines cherts: ages and

- 1664 distribution. In: *Ressources lithiques, productions et transferts entre Alpes et Méditerranée. Séances*
1665 *de la SPF*, pp. 55-75.
- 1666 Bertola, S., Broglio, A., Cassoli, P.F., Cilli, C., Cusinato, A., Dalmeri, G., De Curtis, O., De Stefani,
1667 M., Di Giuseppe, Z., Dini, M., Fiore, I., Fontana, F., Ghinassi, M., Giacobini, G., Govoni, L.,
1668 Guerreschi, A., Gurioli, F., Lemorini, C., Liagre, J., Locatelli, E., Lo Vetro, D., Malerba, G.,
1669 Martini, F., Martino, G., Montoya, C., Palma Di Cesnola, A., Peresani, M., Ricciardi, S., Rocci
1670 Ris, A., Rossetti, P., Sala, B., Silvestrini, M., Tagliacozzo, A., Tozzi, C., Ziggliotti, S., 2007.
1671 L'Epigravettiano recente nell'area prealpina e alpina orientale. In: Martini, F. (Ed.), *L'Italia tra*
1672 *15.000 e 10.000 anni fa. Cosmopolitismo e regionalità nel Tardoglaciale, Millenni, Studi di*
1673 *Archeologia Preistorica*, Firenze, 5, pp. 39-94.
- 1674 Bertola, S., Visentin, D., Fontana, F., 2018. Lithic raw material circulation and settlement dynamics
1675 in the Upper Palaeolithic of the Venetian Prealps (NE Italy). A key-role for palaeoclimatic and
1676 landscape changes across the LGM? in: Borgia, V., Cristiani, E. (Eds.), *Palaeolithic Italy.*
1677 *Advanced studies on early human adaptations in the Apennine peninsula*, Leiden: Sidestone
1678 Press., pp. 219-246.
- 1679 Bertotti, G., Picotti, V., Bernoulli, D., Castellarin, A., 1993. From rifting to drifting: tectonic
1680 evolution of the South-Alpine upper crust from the Triassic to the Early Cretaceous. *Sed. Geol.*
1681 86, 53-76.
- 1682 Bertran, P., Sitzia, L., Banks, W.E., Bateman, M.D., Demars, P.Y., Hernandez, M., Lenoir, M.,
1683 Mercier, M., Prodeo, F. 2013. The Landes de Gascogne (Southwest France): periglacial desert and
1684 cultural frontier during the Palaeolithic. *J. Archaeol. Sci.* 40(5), 2274–2285.
- 1685 Biagi, P., 1976. Strumento litico del Paleolitico superiore dalla Caverna Buis dei Lader (97 LO)
1686 *Natura Bresciana* 13, 117-120.
- 1687 Biagi, P., 2000. La preistoria del territorio di Rezzato. In: Taccolini, M., (ed.), *Rezzato. Storia di*
1688 *una comunità. Terre Bresciane*, 11-20.
- 1689 Bietti, A., 1979. Le gisement paléolithique supérieur de Taurisano (Lecce, Italie) et sa position
1690 chronologique et culturelle dans l'Epigravettien italien. In: de Sonneville-Bordes D., (ed.), *La fin*
1691 *des temps glaciaires en Europe*, CNRS, pp. 333-344.
- 1692 Bietti, A., 1997. Considérations sur la définition de l'Epigravettien ancien en Italie. In: Fullola, N.,
1693 Soler, J.M. (Eds.), *El mon mediterrani deprés del Pleniglacial (18.000-12.000 BP). Sèrie*
1694 *Monogràfica*, 17, Museu d'Arqueologia de Catalunya, Girona, pp. 131-146.
- 1695 Bietti, A., Molari, C. 1994. The Upper Pleistocene deposit of the Arene Candide cave (Savona;
1696 Italy): general introduction and stratigraphy. In: Bietti, A., (ed.) *The Upper Pleistocene deposits of*

- 1697 the Arene Candide Cave (Savona, Italy). New studies on the 1940-42 excavations. *Quaternaria*
1698 *Nova IV*: 9-27.
- 1699 Billard, C., Daire, M.Y., Martin, C., Billaud, Y., Bizien-Jaglin, C., Chancerel, A., Cliquet, D.,
1700 Fourment, N., Gandois, H., Huet, B., Laforge, M., Langouët, L., Laporte, L., Large, J.M., Leroy,
1701 F., López-Romero, E., Maurel, L., Monnier, J.L., Régaldo, P., Ropars, A., Stéphan, P., Vallin, L.
1702 2020. France: Submerged Prehistory on Atlantic and Mediterranean Coasts. In: Bailey, G.,
1703 Galanidou, N., Peeters, H., Jöns, H., Mennenga, M. (Eds), *The Archaeology of Europe's Drowned*
1704 *Landscapes*. Springer Open, Coastal Research Library 35, pp. 249-279.
- 1705 Blyakharchuk, T.A., Wright, H.E., Borodavko, P.S., van der Knaap, W.O., Ammann, B., 2008. The
1706 role of Pingos in the development of the Dzhangyskol lake-Pingo complex, central Altai
1707 Mountains, Southern Siberia. *Palaeogeography, Palaeoclimatology, Palaeoecology* 254 (4), 404-
1708 420.
- 1709 Bocherens, H., Hofman-Kamińska, E., Drucker, D.G., Schmölcke, U., Kowalczyk, R., 2015.
1710 European Bison as a Refugee Species? Evidence from Isotopic Data on Early Holocene Bison and
1711 Other Large Herbivores in Northern Europe. *PLoS ONE* 10(2): e0115090.
- 1712 Bocquet-Appel, J.P., Demars, P.Y., Noiret, L., Dobrowsky, D., 2005. Estimates of Upper
1713 Palaeolithic meta-population size in Europe from archaeological data. *J. Archaeol. Sci.* 32, 1656-
1714 1668.
- 1715 Bodu, P., Bouché, F., Ballinger, M., Dumarçay, G., Goutas, N., Lacarrière, J., Legrand-Pineau, A.,
1716 Lucas, C., Naton, H.G., Théry-Parisot, I. 2019. The site of Les Bossats in ormesson (Seine-et-
1717 Marne, France): a vast solutrean campsite in the Paris Basin. In: Schmidt, I., Cascalheira, J. (Eds.),
1718 *Human adaptations to the Last Glacial Maximum*. Cambridge Scholars Publishing, pp. 26-43.
- 1719 Bolli, H.M., Saunders, J.B., Perch Nilsen, K., (eds), 1985. *Plankton Stratigraphy*. Cambridge Earth
1720 Science Series: Cambridge University Press.
- 1721 Borić, D., Cristiani, E., 2016. Social Networks and Connectivity among the Palaeolithic and
1722 Mesolithic Foragers of the Balkans and Italy. In: Krauss, R., Floss, H., (eds.), *Southeast Europe*
1723 *before Neolithisation*. Tübingen, pp. 73–112.
- 1724 Boschian, G., Fusco, F., 2007. Figuring out no-one's land. Was the Karst deserted in the Late-
1725 Glacial? In: Whallon, R. (Ed.), *Late Paleolithic Environments and Cultural Relations around the*
1726 *Adriatic*. British Archaeological Reports International Series 1716, Oxford, pp. 15-26.
- 1727 Bosellini, A., 1965. Lineamenti strutturali delle Alpi Meridionali durante il Permo-Trias, e alcune
1728 considerazioni sui possibili rapporti con la tettonica alpidica. *Memorie Museo Storia Naturale*
1729 *Veneto Tridentino* 15(3), 1-68.

- 1730 Bosellini, A., 1973. Modello geodinamico e paleotettonico delle Alpi Meridionali durante il
1731 Giurassico-Cretaceo. Sue possibili applicazioni agli Appennini. In: Accordi, B., (ed.) *Moderne*
1732 *vedute sulla geologia dell'Appennino*, Roma. Accademia Nazionale dei Lincei Quaderno 183,
1733 163-205.
- 1734 Bosellini, A., Winterer, E.L., 1975. Pelagic limestone and radiolarite of the Tethian Mesozoic: a
1735 genetic model. *Geology* 3, 279-282.
- 1736 Bosinski, G., 1999. The period 30,000–20,000 BP in the Rhineland, in: Roebroeks, W., Mussi, M.,
1737 Svoboda, J., Fennema, K. (Eds.), *Hunters of the Golden Age: The Mid Upper Palaeolithic of*
1738 *Eurasia 30,000–20,000 BP*. Leiden, University of Leiden, pp. 271–280.
- 1739 Braakhekke, J., Ivy-Ochs, S., Monegato, G., Gianotti, F., Martin, S., Casale, S., Christl, M., 2020.
1740 Timing and flow pattern of the Orta Glacier (European Alps) during the Last Glacial Maximum.
1741 *Boreas* 49, 315-332.
- 1742 Breda, M., 2001. *Alces alces* (Linnaeus, 1758) del Pleistocene superiore e dell'Olocene antico in
1743 Italia Nord-Orientale. *Bollettino del Museo Civico di Storia Naturale di Verona*, 25 (Geologia,
1744 Paleontologia e Preistoria), 27-39.
- 1745 Breda, M., 2002. Pleistocene fossil *Alces* (Cervidae, Mammalia) from Lombardy and Emilia
1746 Romagna (North Italy). *Memorie di Scienze Geologiche* 54, 51-63.
- 1747 Broglio, A., 1994. Il Paleolitico superiore del Friuli-Venezia Giulia. In: *Atti XXIX Riunione*
1748 *Scientifica Istituto Italiano di Preistoria e Protostoria*, pp. 37-56.
- 1749 Broglio, A., 1997. Considérations sur l'Épigravettien italique. In: Fullola, N., Soler, J.M. (Eds.), *El*
1750 *mon mediterrani deprés del Pleniglacial (18.000-12.000 BP)*. Sèrie Monogràfica, 17, Museu
1751 d'Arqueologia de Catalunya, Girona, pp. 147-157.
- 1752 Broglio, A., Improta, S., 1995. Nuovi dati di cronologia assoluta del Paleolitico superiore e del
1753 Mesolitico del Veneto, del Trentino e del Friuli. *Atti Istituto Veneto Scienze, Lettere e Arti* 153,
1754 1–45.
- 1755 Broglio, A., Chelidonio, G., Longo, L., 1993. Analyse morphologique et fonctionnelle des pointes à
1756 cran de l'Épigravettien ancien. In: Anderson, P.C., Beyries, S., Otte, M., Plisson, H. (Eds.) *Actes*
1757 *du Colloque International Traces et fonction: les gestes retrouvés*. ERAUL, Liège, pp. 31-39.
- 1758 Broglio, A., Coltorti, M., Peresani, M., Silvestrini, M., 2005. Il Paleolitico delle Marche. *Atti*
1759 *XXXVIII Riunione Scientifica Istituto Italiano di Preistoria e Protostoria*, 25-51.
- 1760 Broglio, A., Bertola, S., De Stefani, M., Gurioli, F., 2009. The shouldered points of the Early
1761 Epigravettian of the Berici Hills (Venetian Region, North Italy). Materials, blanks, typology,
1762 exploitation. In: Burdukiewicz, J.M., Cyrek, K., Dyczek, P., Szymczak, K. (Eds.), *Understanding*

- 1763 the Past. Center for Research on the Antiquity of Southeastern Europe, University of Warsaw, pp.
1764 59-68.
- 1765 Brugal, J.P., David, F., Enloe, J., Jaubert, J., Eds.), 1999. Le Bison: gibier et moyen de subsistance
1766 des hommes du Paleolithique aux Paléindiens des Grandes Plaines. Centre de Recherches
1767 Archéologiques. Editions APDCA, Antibes.
- 1768 Bruno, L., Amorosi, A., Severi, P., Bartolomei, P., 2015. High-frequency depositional cycles within
1769 the late Quaternary alluvial succession of Reno River (northern Italy). *It. J. Geosci.* 134, 339–354.
- 1770 Bruno, L., Piccin, A., Sammartino, I., Amorosi, A., 2018. Decoupled geomorphic and sedimentary
1771 response of Po River and its Alpine tributaries during the last glacial/post-glacial episode.
1772 *Geomorphology* 317, 184-198.
- 1773 Brunović, D., Miko, S., Hasan, O., Papatheodorou, G., Ilijanić, N., Misericchi, S., Correggiari,
1774 A.M., Geraga, M., 2020. Late Pleistocene and Holocene paleoenvironmental reconstruction of a
1775 drowned karst isolation basin (Lošinj Channel, NE Adriatic Sea). *Palaeogeography,*
1776 *Palaeoclimatology, Palaeoecology* 544.
- 1777 Burke, A., Kageyama, M., Latombe, G., Fasel, M., Vrac, M., Ramstein, G., James, P.M.A., 2017.
1778 Risky business: The impact of climate and climate variability on human population dynamics in
1779 Western Europe during the Last Glacial Maximum. *Quat. Sc. Rev.* 164, 217-229.
- 1780 Cancellieri, M., 2015. Over the hills and far away. Last Glacial Maximum lithic technology around
1781 the Great Adriatic Plain. *Archaeopress Archaeology*, Archaeopress Publishing, Oxford, pp. 125.
- 1782 Carrera, L., Pavia, M., Romandini, M., Peresani, M., 2018a. Avian fossil assemblages at the onset
1783 of LGM in the Eastern Alps. A palaeological contribution from Rio Secco Cave (Italy). *C. R.*
1784 *Palevol* 17, 166-177.
- 1785 Carrera, L., Pavia, M., Peresani, M., Romandini, M., 2018b. Late Pleistocene fossil birds from Buso
1786 Doppio del Broion Cave (North-Eastern Italy): implications for palaeoecology, palaeoenvironment
1787 and palaeoclimate. *Boll. Soc. Paleontol. It.* 57(2), 145-174.
- 1788 Carton, A., Bondesan, A., Fontana, A., Meneghel, M., Miola, A., Mozzi, P., Primon, S., Surian, N.,
1789 2009. Geomorphological evolution and sediment transfer in the Piave River watershed (north-
1790 eastern Italy) since the LGM. *Géomorphologie: Relief. Process. Environ.* 3, 37–58.
- 1791 Casadoro, G., Castiglioni, G.B., Corona, E., Massari, F., Moretto, M.G., Paganelli, A., Terenziani,
1792 F., Toniello, V., 1976. Un deposito tardowürmiano con tronchi subfossili alle Fornaci di Revine
1793 (Treviso). *Boll. Com. Glac. It.* 24, 22-63.
- 1794 Castiglioni, G.B., Ajassa, R., Baroni, C., Biancotti, A., Bondesan, A., Bondesan, M., Brancucci, G.,
1795 Castaldini, D., Castellaccio, E., Cavallin, A., Cortemiglia, F., Cortemiglia, G.C., Cremaschi, M.,
1796 Da Rold, O., Elmi, C., Favero, V., Ferri, R., Gandini, F., Gasperi, G., Giorgi, G., Marchetti, G.,

- 1797 Marchetti, M., Marocco, R., Meneghel, M., Motta, M., Nesci, O., Orombelli, G., Paronuzzi, P.,
1798 Pellegrini, G.B., Pellegrini, L., Rigoni, A., Sommaruga, M., Sorbini, L., Tellini, C., Turrini, M.C.,
1799 Vaia, F., Vercesi, P.L., Zecchi, R., Zorzin, R., 1997. Carta Geomorfologica della Pianura Padana. 3
1800 Fogli alla scala 1:250.000. Firenze: S.E.L.C.A.
- 1801 Cattani, L., Renault-Miskovsky, J., 1983. Etude pollinique du remplissage de la Grotte du Broion
1802 (Vicenza, Italie): Paléoclimatologie du Würmien en Vénétie. Bull. Ass. Fr. Et. Quat. 1983-4, 197-
1803 212.
- 1804 Cavallo, G., Fontana, F., Gonzato, F., Peresani, M., Riccardi, M.P., Zorzin, R., 2017. Textural,
1805 microstructural and compositional characteristics of Fe-based geomaterials and Upper Palaeolithic
1806 ocher in the Lessini Mountains, Northeast Italy: implications for provenance studies. *Geoarch.*
1807 32(4), 437-455.
- 1808 Cheddadi, R., Bennett, K.D., 2020. Past climate changes and the role of refugia in the temperate
1809 Northern Hemisphere. *PAGES Magazine* 28(1), 8-9.
- 1810 Cremaschi, M., 1987. Loess deposits of the Plain of the Po and of the adjoining Adriatic basin
1811 (Northern Italy). In: Pecs, M., French, H.M. (Eds.), *Loess and Periglacial Phenomena*. Akademiai
1812 Kiado, Budapest, pp. 125–140.
- 1813 Cremaschi, M., 1990. The Loess in Northern and Central Italy: a Loess Basin between the Alps and
1814 the Mediterranean Sea. C.N.R., Centro di Studio per la Stratigrafia e Petrografia delle Alpi
1815 Centrale, Milano, Italy.
- 1816 Cremaschi, M., Nicosia, C., 2012. Sub-Boreal aggradation along the Apennine margin of the
1817 Central Po Plain: geomorphological and geoarchaeological aspects. *Geomorphologie* 2, 155–174.
- 1818 Cremaschi, M., Zerboni, A., Nicosia, C., Negrino, F., Rodnight, H., Spötl, C., 2015. Age, soil-
1819 forming processes, and archaeology of the loess deposits at the Apennine margin of the Po Plain
1820 (northern Italy). *New insights from the Ghiardo area. Quat. Int.* 376, 173-188.
- 1821 Cristiani, E., Farbstein, R., Miracle, P., 2014. Ornamental traditions in the Eastern Adriatic: The
1822 Upper Paleolithic and Mesolithic personal adornments from Vela Spila (Croatia). *J. Anthr. Arch.*
1823 36, 21-31.
- 1824 Cvitkušić, B., 2017. Upper Palaeolithic and Mesolithic ornamental traditions in the Eastern Adriatic
1825 coast and hinterland. *Coll. Antropol.* 41(1), 45-59.
- 1826 Cvitkušić, B., Radović, S., Vujević, D., 2018. Changes in ornamental traditions and subsistence
1827 strategies during the Palaeolithic-Mesolithic transition in Vlakno cave. *Quat. Int.* 494, 180-192.
- 1828 Chytrý, M., Danihelka, J., Kubešová, S., Lustyk, P., Ermakov, N., Hájek, M., Hájková, P., Koci,
1829 M., Otypkova, Z., Rolecek, J., Reznickova, M., Smarda, P., Valachovic, M., Popov, D., Pisut, I.,

- 1830 2008. Diversity of forest vegetation across a strong gradient of climatic continentality: Western
1831 Sayan Mountains, southern Siberia. *Plant Ecol.* 196(1), 61–83.
- 1832 Cita Sironi, M.B., 1964. Ricerche micropaleontologiche e stratigrafiche sui sedimenti pelagici del
1833 Giurassico superiore e del Cretaceo inferiore nella catena del Monte Baldo, *Riv. It. Pal., Mem.* 10,
1834 1-182.
- 1835 De Marchi, L., 1922. Variazioni del livello dell'Adriatico in corrispondenza con le espansioni
1836 glaciali. *Atti Accademia Scientifica Veneto-Trentino-Istria* 12-13, 1–15.
- 1837 De Stefani, M., Gurioli, F., Ziggioni, S., 2005. Il Paleolitico superiore del Riparo del Broion nei
1838 Colli Berici (Vicenza). *Rivista Scienze Preistoriche, Suppl.* 1, 93-107.
- 1839 Delmas, M., 2015. The Last Maximum Ice Extent and subsequent deglaciation of the Pyrenees: an
1840 overview of recent research *Cuadernos de Investigación. Geográfica* 41, 359-387.
- 1841 Demidenko, Yu.E., 2008. The Early and Mid Upper Palaeolithic of the North Black sea region: an
1842 overview. *Quartär* 55, 99-114.
- 1843 Djindjian, F., Kozłowski, J.K., Otte, M., 1999. *Le Paléolithique supérieur en Europe*. Colin ed.
1844 Paris.
- 1845 Dobosi, V., 2000. Interior parts of the Carpatian Basin between 30,000 and 20,000 BP. In:
1846 Roebroeks, W., Mussi, M., Svoboda, J., Fennema, K. (Eds.), *Hunters of the Golden Age: The Mid*
1847 *Upper Palaeolithic of Eurasia 30,000–20,000 BP*. Leiden, University of Leiden, pp. 231–239.
- 1848 Dobrowski, S.Z., 2011. A climatic basis for microrefugia: the influence of terrain on climate. *Gl.*
1849 *Ch. Biol.* 17, 1022-1035.
- 1850 Ducasse, S., 2012. What is left of the Badegoulian “interlude”? New data on cultural evolution in
1851 southern France between 23,500 and 20,500 cal. BP. *Quat. Int.* 272-273, 150-165.
- 1852 Ehlers, J., Gibbard, P.L., Hughes, P.D., 2011. *Quaternary Glaciations - Extent and Chronology*, vol.
1853 15, Elsevier, Amsterdam.
- 1854 Erba, E., Quadrio, B. 1987. Biostratigrafia a Nannofossili calcarei, Calpionellidi e Foraminiferi
1855 planctonici della Maiolica (Turoniano superiore - Aptiano) nelle Prealpi bresciane (Italia
1856 settentrionale). *Riv. It. Paleont. Strat.* 93(1), 3-108.
- 1857 Falcucci, A., Peresani, M., in press. A pre-Heinrich Event 3 assemblage at Fumane Cave and its
1858 contribution for understanding the beginning of the Gravettian in Italy. *Quartär*.
- 1859 Farr, R.H., Momber, G., Satchell, J., Flemming, N.C., 2017. Paleolandscapes of the Celtic Sea and
1860 the Channel/La Manche. In: Flemming, N.C., Harff, J., Moura, D., Burgess, A., Bailey, G.N. (eds)
1861 *Submerged landscapes of the European continental shelf: Quaternary Paleoenvironments*. Wiley,
1862 Chichester, pp 211–239

- 1863 Féblot-Augustins, J., 1997. La circulation des matières premières au Paléolithique. ERAUL 75,
1864 tome 1.
- 1865 Federici, P.R., Ribolini, A., Spagnolo, M., 2017. T glacial history of the Maritime Alps from the
1866 last glacial maximum to the little ice age. *Geol. Soc. Lond. Spec. Publ.* 433, SP433-SP439.
- 1867 Feldman, M., Fernandez-Dominguez, E., Reynolds, L., Baird, D., Pearson, J., Hershkovitz, I., May,
1868 H., Goring-Morris, N., Benz, M., Gresky, J., Bianco, R.A., Fairbairn, A., Mustafaoğlu, G.,
1869 Stockhammer, P.W., Posth, C., Haak, W., Jeong, C., Krause, J., 2019. Late Pleistocene human
1870 genome suggests a local origin for the first farmers of central Anatolia. *Nat. Commun.* 10, 1218.
- 1871 Felja, I., Fontana, A., Furlani, S., Bajraktarević, Z., Paradžik, A., Topalović, E., Rossato, S.,
1872 Cosović, V., Juračić, M., 2015. Environmental changes in the lower Mirna river valley (Istria,
1873 Croatia) during the middle and late Holocene. *Geol. Croat.* 68, 209-224.
- 1874 Finsinger, W., Belis, C., Blockley, S.P.E., Eicher, U., Leuenberger, M.C., Lotter, A.F., Ammann,
1875 B., 2008. Temporal patterns in lacustrine stable isotopes as evidence for climate change during the
1876 late glacial in the Southern European Alps. *J. Paleolimn.* 40, 885-895.
- 1877 Fontana, A., Ferrari, S., 2020. Interazione tra processi tettonici, alluvionali, eolici e pedogenetici
1878 nell'area di Sammardenchia e Pozzuolo del Friuli. *Gortania. Geol., Paleont., Paletn.* 41, 43-60.
- 1879 Fontana, A., Mozzi, P., Bondesan, A., 2008. Alluvial megafans in the Venetian–Friulian Plain
1880 (north-eastern Italy): evidence of sedimentary and erosive phases during Late Pleistocene and
1881 Holocene. *Quat. Int.* 189, 71–90.
- 1882 Fontana, A., Mozzi, P., Bondesan, A., 2010. Late Pleistocene evolution of the Venetian-Friulian
1883 Plain. *Rendiconti Lincei Scienze Fisiche e Naturali* 21, Suppl. 1, 181-196.
- 1884 Fontana, A., Mozzi, P., Marchetti, M., 2014a. Alluvial fans and megafans along the southern side of
1885 the Alps. *Sedim. Geol.* 301, 150-171.
- 1886 Fontana, A., Monegato, G., Devoto, S., Zavagno, E., Burla, I., Cucchi, F., 2014b.
1887 Geomorphological evolution of an Alpine fluvio-glacial system at the LGM decay: the Cormor
1888 type megafan (NE Italy). *Geomorph.* 204, 136-153.
- 1889 Fontana, F., Cilli, C., Cremona, G., Giacobini, G., Gurioli, F., Liagre, J., Malerba, G., Rocci Ris,
1890 A., Veronese, C., Guerreschi, A., 2009. Recent data on the Late Epigravettian occupation at
1891 Riparo Tagliente, Monti Lessini (Grezzana, Verona): a multidisciplinary perspective. *Preistoria*
1892 *Alpina* 44, 51-59.
- 1893 Fontana, F., Cremona, M., Falceri, L., Gajardo, A., Ndiaye, M., Neri, A., Visentin, D., Bertola, S.,
1894 Guerreschi, A., 2012. Lithic Technical Systems in the First Part of the Late Glacial at Riparo
1895 Tagliente (Stallavena Di Grezzana, Verona). *J. Biol. Res.* LXXXIV(1), 102–103.

- 1896 Fontana, F., Falceri, L., Gajardo, A., Bertola, S., Cremona, M.G., Cavulli, F., Guerreschi, A.,
 1897 Visentin, D., 2018. Re-colonising the Southern alpine fringe: diachronic data on the use of
 1898 sheltered space in the late Epigravettian site of Riparo Tagliente. In: Borgia, V., Cristiani, E.
 1899 (Eds.), *Palaeolithic Italy. Advanced studies on early human adaptation in the Apennine Peninsula*,
 1900 Leiden: Sidestone Press, pp. 287-310.
- 1901 Fontana, F., Guerreschi, A., Bertola, S., Cremona, M.G., Cavulli, F., Falceri, L., Gajardo, A.,
 1902 Montoya, C., Ndiaye, M., Visentin, D., 2015. I livelli più antichi della serie epigravettiana
 1903 “interna” di Riparo Tagliente: sfruttamento delle risorse litiche e sistemi tecnici. In: Leonardi, G.,
 1904 Tiné, V. (Ed.), *Preistoria e Protostoria del Veneto, Studi di Preistoria e Protostoria*, 2, Firenze, pp.
 1905 43–52.
- 1906 Frajman, B., Schöwnswetter, P., 2017. Amphi-Adriatic distributions in plants revisited: Pleistocene
 1907 trans-Adriatic dispersal in the *Euphorbia barrelieri* group (Euphorbiaceae). *Bot. J. Linn. Soc.*
 1908 185(2), 240-252.
- 1909 Frigerio, C., Bonadeo, L., Zerboni, A., Livio, F., Ferrario, M.F., Fioraso, G., Irace, A., Brunamonte,
 1910 F., Michetti, A.M., 2017. First evidence for Late Pleistocene to Holocene earthquake surface
 1911 faulting in the Eastern Monferrato Arc (Northern Italy): geology, pedostratigraphy and structural
 1912 study of the Pecetto di Valenza site. *Quat. Int.* 451, 143–164.
- 1913 Fu, Q., Posth, C., Hajdinjak, M., Petr, M., Mallick, S., Fernandes, D., Furtwängler, A., Haak, W.,
 1914 Meyer, M., Mittnik, A., Nickel, B., Peltzer, A., Rohland, N., Slon, V., Talamo, S., Lazaridis, I.,
 1915 Lipson, M., Mathieson, I., Schiffels, S., Skoglund, P., Derevianko, A.P., Drozdov, N., Slavinsky,
 1916 V., Tsybankov, A., Cremonesi, R.G., Mallegni, F., Gély, B., Vacca, E., Morales, M.R., Straus,
 1917 L.G., Neugebauer-Maresch, C., Teschler-Nicola, M., Constantin, S., Moldovan O.T., Benazzi, S.,
 1918 Peresani, M., Coppola, D., Lari, M., Ricci, S., Ronchitelli, A., Valentin, F., Thevenet, C.,
 1919 Wehrberger, K., Grigorescu, D., Rougier, H., Crevecoeur, I., Flas, D., Semal, P., Mannino, M.A.,
 1920 Cupillard, C., Bocherens, H., Conard, N.J., Harvati, K., Moiseyev, V., Drucker, D.G., Svoboda, J.,
 1921 Richards, M.P., Caramelli, D., Pinhasi, R., Kelso, J., Patterson, N., Krause, J., Pääbo, S., Reich,
 1922 D., 2016. The genetic history of Ice Age Europe. *Nature* 534, 200-205.
- 1923 Fuček, L., 2009. Karbonatna platforma Krških Dinarida; Rudisti i vapnenci. In I. Velić and I.
 1924 Vlahović, eds. *Tumač Geološke karte Republike Hrvatske 1: 300 000*. Zagreb: Hrvatski geološki
 1925 institut, 66–69.
- 1926 Furlani, S., Finocchiaro, F., Boschian, G., Lenaz, D., Biolchi, S., Boccali, C., Monegato, G.,
 1927 2016. Quaternary evolution of the fluviokarst Rosandra valley (Trieste, NE Italy). *Alp. Mediterr.*
 1928 *Quat.* 29, 169–179.
- 1929 Gambassini, P., 2007. Traits essentiels du Gravettien en Italie. *Paléo* 19, 105-109.

- 1930 Gamble, C., Davies, W., Pettitt, P., Hazelwood, L., Richards, M., 2006. The Late Glacial ancestry
1931 of Europeans: combining genetic and archaeological evidence. *Doc. Praehist.* XXXIII, 1-10.
- 1932 Gazzoni, V., Goude, G., Herrscher, E., Guerreschi, A., Antonioli, F., Fontana, F., 2013. Late Upper
1933 Palaeolithic human diet: first stable isotope evidence from Riparo Tagliente (Verona, Italy). *Bull.*
1934 *Mém. Soc. Anthropol. Paris* 25, 103-117.
- 1935 Gehrig, R. 1997. Pollenanalytische Untersuchungen zur Vegetations- und Klimageschichte des Val
1936 Camonica (Norditalien). J. Cramer, Berlin - Stuttgart.
- 1937 Geological Society of America, 1964, *Rock-Color Chart*, 2nd ed. New York.
- 1938 Gerasimenko, N., 2011. Climatic and environmental oscillations in southeastern Ukraine from 30 to
1939 10 ka, inferred from pollen and lithopedology. *Special Paper of the Geological Society of America*
1940 473, 117-132.
- 1941 Ghinoi, A., Soldati, M. 2017. Reappraisal of lateglacial stadials in the Eastern Alps: the case study
1942 of Valparola (eastern Dolomites, Italy). *Alp. Medit. Quat.* 30, 51-67.
- 1943 Giaccio, B., Rolfo, M., Galadini, F., Messina, P., Silvestrini, M., Sposato, A., 2004. La risposta
1944 ambientale ed umana alle oscillazioni climatiche sub-orbitali dello Stadiale Isotopico 3: evidenze
1945 geoarcheologiche dal sito paleolitico di Fonte delle Mattinate (Piana di Colfiorito, Appennino
1946 centrale). *Il Quaternario: Italian Journal of Quaternary Sciences* 17(2/1), 239-256.
- 1947 Gianotti, F., Forno, M.G., Ivy-Ochs, S., Monegato, G., Pini, R., Ravazzi, C., 2015. Stratigraphy of
1948 the Ivrea morainic amphitheatre (NW Italy): an updated synthesis. *Alp. Medit. Quat.* 28, 29-58.
- 1949 Giraudi, C., 2017. The morphology of the base of the alluvial sediments of the Vercelli Plain
1950 (Piedmont, NW Italy): an integration of the knowledge on the Quaternary geological evolution.
1951 *Alp. Medit. Quat.* 30, 93-103.
- 1952 Giuliano, G., Mari, G.M., Cavallin, A., De Amicis, M., 1998. Ricerca sulla vulnerabilità naturale e
1953 sul rischio di inquinamento delle acque sotterranee nella Pianura Padana e Veneto Friulana: Carta
1954 della infiltrabilità regionale, Carta idrogeologica regionale, Carta della vulnerabilità regionale
1955 (scala 1:500.000). *Memorie descrittive della Carta Geologica d'Italia. Servizio Geologico*
1956 *Nazionale, Istituto Poligrafico e Zecca dello Stato, Roma, Volume LVI, pp.102.*
- 1957 Gorbunov, A.P., 1978. Permafrost investigations in high mountain regions. *Arctic and Alpine*
1958 *Research*, 10, 283-294.
- 1959 Gretzinger, J., Molak, M., Reiter, E., Pfrengle, S., Urban, C., Neukamm, J., Blant, M., Conard, N.J.,
1960 Cupillard, C., Dimitrijević, V., Drucker, D.G., Hofman-Kamińska, E., Kowalczyk, R., Krajcarz,
1961 M.T., Krajcarz, M., Münzel, S.C., Peresani, M., Romandini, M., Rufí, I., Soler, J., Terlato, G.,
1962 Krause, J., Bocherens, H., Schuenemann, V.J., 2019. Large-scale mitogenomic analysis of the
1963 phylogeography of the Late Pleistocene cave bear. *Nat. Sc. Rep.* 9, 10700.

- 1964 Gubler, M., Henne, P.D., Schwörer, C., Boltshauser-Kaltenrieder, P., Lotter, A.F., Brönnimann, S.,
1965 Tinner, W., 2018. Microclimatic gradients provide evidence for a glacial refugium for temperate
1966 trees in a sheltered hilly landscape of Northern Italy. *J. Biog.* 45, 2564-2575.
- 1967 Guerreschi, A., Veggiani, C., 1983. Il deposito del Paleolitico superiore della Fornace di San
1968 Damiano. In: Peretto, C., Prati (eds): *Le più antiche tracce dell'uomo nel territorio forlivese e*
1969 *faentino*. Grafiche M.D.M Forlì.
- 1970 Guerreschi, A., Veronese, C. 2002. L'Epigravettiano di Riparo Tagliente: evidenze archeologiche di
1971 comportamenti simbolici. In: *Aspes A (ed) Preistoria Veronese. Contributi e aggiornamenti.*
1972 *Memorie del Museo Civico di Storia Naturale di Verona* 5: 42-7.
- 1973 Gupta, S., Collier, J., Palmer-Felgate, A., Dickinson, J., Bushe, K., Humber, S., 2008. Submerged
1974 Palaeo-Arun and Solent Rivers: Reconstruction of Prehistoric Landscapes. Final Report English
1975 Heritage.
- 1976 Gurioli, F., 2005. Oggetti ornamentali del Gravettiano di Ponte di Pietra e dell'Epigravettiano
1977 Grotta del Prete e Cava Romita (Ancona). *Atti XXXVIII Riunione Scientifica Istituto Italiano di*
1978 *Preistoria e Protostoria*, 790-793.
- 1979 Guthrie, R.D., 1990. *Frozen Fauna of the Mammoth Steppe: the Story of Blue Babe*. University of
1980 Chicago Press, Chicago.
- 1981 Heiss, A.G., Kofler, W., Oeggl, K., 2005. The Ulten Valley in South Tyrol, Italy: Vegetation and
1982 Settlement History of the Area, and Macrofossil Record from the Iron Age Cult Site of St.
1983 Walburg. *Palyno-Bulletin Institute of Botany, Innsbruck* 1-2, 63-73.
- 1984 Hippe, K., Fontana, A., Hajdas, I., Ivy-Ochs, S., 2018. A high-resolution ¹⁴C chronology tracks
1985 pulses of aggradation of glaciofluvial sediment on the Cormor megafan between 45 and 20 ka BP.
1986 *Radiocarbon* 60, 857-874.
- 1987 Holtmeier, F., 2009. *Mountain Timberlines, Mountain Timberlines*. Springer Netherlands.
- 1988 Hrvatski geološki institut, 2009. *Geološka karta Republike Hrvatske 1: 300 000*. Zagreb: Hrvatski
1989 geološki institut.
- 1990 Hublin, J. J., Roebroeks, W., 2009. Ebb and flow or regional extinctions? On the character of
1991 Neandertal occupation of northern environments. *C. R. Palevol* 8, 503-509.
- 1992 Hughes, A.L.C., Gyllencreutz, R., Lohne, Ø.S., Mangerud, J., Svendsen, J.I., 2016. The last
1993 Eurasian ice sheets - a chronological database and time-slice reconstruction, DATED-1. *Boreas*,
1994 45, 1-45.
- 1995 Ivy-Ochs, S., Kerschner, H., Maisch, M., Christl, M., Kubik, P.W., Schlüchter, C., 2009. Latest
1996 Pleistocene and Holocene glacier variations in the European alps. *Quat. Sci. Rev.* 28, 2137-2149.

- 1997 Ivy-Ochs, S., Lucchesi, L., Baggio, P., Fioraso, G., Gianotti, F., Monegato, G., Graf, A., Akçar, N.,
1998 Christl, M., Carraro, F., Forno, M.G., Schlüchter, C., 2018. New geomorphological and
1999 chronological constraints for glacial deposits in the Rivoli-Avigliana end-moraine system and the
2000 lower Susa Valley (Western Alps, NW Italy). *J. Quat. Sci.* 33, 550-562.
- 2001 Jacobi, R.M., Higham, T.F.G., 2008. The ‘Red Lady’ ages gracefully: new ultrafiltration AMS
2002 determinations from Paviland. *J. Hum. Evol.* 898-907.
- 2003 Janković, I., Komšo, D., Ahern, J.C.M., Becker, R., Gerometta, K., S. Mihelić, S., Zubčić, K., 2015.
2004 Archaeological Investigation of the Lim Channel in 2014 and 2015 at Romuald’s Cave, Abri
2005 Kontija 002, Pećina Cave near Rovinjsko Selo, Lim 001 and an Underwater Survey of the Lim
2006 Channel. *Histria archaeologica* 46, 5–23.
- 2007 Janković, I., Komšo, D., Ahern, J.C.M., Becker, R., Gerometta, K., Weinstock, J., Barbir, A.,
2008 Vukosavljević, N., Cvitkušić, B., Zubčić, K., Mihelić, S., Smith, F.H., 2017. New Research on the
2009 Late Pleistocene and Early Holocene in the Lim Channel, Istria. *Antiquity* 91(359-364), 1-7.
- 2010 Julien, M.A., Bocherens, H., Burke, A., Drucker, D.G., Patou-Mathis, M., Krotova, O., Péan, S.,
2011 2012. Were European steppe bison migratory? 18O, 13C and Sr intra-tooth isotopic variations
2012 applied to a palaeoethological reconstruction. *Quat. Int.* 271, 106–119.
- 2013 Kadurin, S., Yanko-Hombach, V., Smyntyna, O., 2020. The Ukraine: In search of submerged Late
2014 Palaeolithic sites on the North-Western Black Sea shelf. In: Bailey, G., Galanidou, N., Peeters, H.,
2015 Jöns, H., Mennenga, M. (Eds), *The Archaeology of Europe’s Drowned Landscapes*. Springer
2016 Open, Coastal Research Library 35, pp. 413-428.
- 2017 Kaplin, P. A., Selivanov, A.O., 2004. Lateglacial and Holocene sea level changes in semi-enclosed
2018 seas of North Eurasia: examples from the contrasting Black and White Seas. *P. P. P.* 209, 19-36.
- 2019 Karavanić, I., 2003. L’industrie aurignacienne de la grotte de Šandalja II (Istrie, Croatie) dans le
2020 contexte de la région de l’Est de l’Adriatique. *L’Anthropologie* 107, 577-602.
- 2021 Karavanić, I., Ahern, J.C.M., Šošić, R., Vukosavljević, N., 2007. Pećina Zala. *Hrvatski arheološki*
2022 *godišnjak* 3, 213-216.
- 2023 Karavanić, I., Vukosavljević, N., Šošić Klindžić, R., Kurtanjek, D., Zupanić, J., 2013. The Lithic
2024 and Bone Industries of the Epigravettian Layers from Šandalja II Near Pula. *Vjesnik za*
2025 *Arheologiju i Povijest Dalmatinsku* 106, 7-73.
- 2026 Kerley, G.I.H., Kowalczyk, R., Cromsigt, J.P.G.M., 2012. Conservation implications of the refugee
2027 species concept and the European bison: king of the forest or refugee in a marginal habitat?
2028 *Ecography* 35, 519–529.
- 2029 Korbar, T., Montanari, A., Koch, G., Mariani, S., De Paolo, D., Turchyn, A., Miknić, M.,
2030 Tari, V., 2009. Geologic reconnaissance of the island of Velika Palagruža, central Adriatic,

- 2031 Croatia. *Geologia Croatica* 62(2), 75–94.
- 2032 Kozłowski, J.K., 1999. Gravettian/Epigravettian sequences in the Balkans: environment,
2033 technologies, hunting strategies and raw material procurement. In: Bailey, G.N., Adam, E.,
2034 Panagopoulou, E., Perlès C., Zachos, K., (eds.), *The Palaeolithic Archaeology of Greece and*
2035 *adjacent areas. British School at Athens Studies* 3. London, pp. 319–329.
- 2036 Kozłowski, J.K., 2008. The shouldered point horizon and the impact of the LGM on human
2037 settlement distribution in Europe. In: Svoboda, J., (ed.), *Petřkovice. On shouldered points and*
2038 *female figurines. The Dolní Věstonice Studies* 15, Brno, pp. 181–192.
- 2039 Krasińska, M., Krasiński, Z.A., 2013. *European Bison. The Nature Monograph*. Springer.
- 2040 Kromer, B., Spurk, M., Remmele, S., Barbetti, M., Toniello, V., 1998. Segments of atmospheric
2041 ¹⁴C change as derived from late glacial and early Holocene floating tree-ring series. *Radiocarbon*
2042 40, 351-358.
- 2043 Kuhlemann, J., Milivojevic, M., Krumrei, I., Kubik, P.W., 2009. Last glaciation of the Sara range
2044 (Balkan peninsula): increasing dryness from the LGM to the Holocene. *Austrian J. Earth Sci.* 102,
2045 146-158.
- 2046 Kuneš, P., Pelánková, B., Chytrý, M., Jankovská, V., Pokorný, P., Petr, L., 2008. Interpretation of
2047 the last-glacial vegetation of eastern-central Europe using modern analogues from southern
2048 Siberia. *J. Biogeogr.* 35, 2223–2236.
- 2049 Lambeck, K., Rouby, H., Purcell, A., Sun, Y., Sambridge, M., 2014. Sea level and global ice
2050 volumes from the Last Glacial Maximum to the Holocene. *Proc. Natl. Acad. Sci. USA* 111,
2051 15296-15303
- 2052 Laplace, G., 1964. *Essai de Typologie systématique. Annali dell'Università di Ferrara, nuova serie,*
2053 *sezione XV, Paleontologia umana e Paleontologia, I, Supplemento II*, 86.
- 2054 Laplace, G., 1966. *Recherches sur l'origine et l'évolution des complexes leptolithiques. École*
2055 *Française de Rome, suppl 4.*, Paris.
- 2056 Lenzi, F., Nenzioni, G., eds. 1996. *Lettere di Pietra. I depositi pleistocenici: sedimenti, industrie e*
2057 *faune del margine appenninico bolognese, Vol. 2. Bologna: Compositori ed.*
- 2058 Leonardi, P., 1951. La Grotta del Broion nei Colli Berici (Vicenza). *Nuova stazione preistorica con*
2059 *industria paleolitica gravettiana. Rivista Scienze Preistoriche* VI (3-4), 141-150.
- 2060 Leonardi, P., 1954. *Nuove ricerche sulla stratigrafia e sulle industrie del Paleolitico superiore della*
2061 *Grotta del Broion nei Colli Berici (Vicenza), Rivista Scienze Preistoriche* IX (1-2), 89-107.
- 2062 Leonardi, P., Broglio, A., 1960. *Quatrième campagne de fouille dans la Grotte du Broion. Bull. Soc.*
2063 *Etudes Rech. Préhist. Les Eyzies, X*, 110-115.
- 2064 Leonardi, P., Broglio, A., 1962. *Le Paléolithique de la Vénétie. Annali Università di Ferrara*, 1-118.

- 2065 Lollini, D., Silvestrini, M., Broglio, A., Coltorti, M., De Stefani, M., 2005. Ponte di Pietra, sito
2066 all'aperto del Gravettiano finale. I risultati degli scavi 1987-89. Atti XXXVIII Riunione
2067 Scientifica Istituto Italiano di Preistoria e Protostoria, 81-91.
- 2068 López-García, J.M., dalla Valle, C., Cremaschi, M., Peresani, M., 2015. Reconstruction of the
2069 Neanderthal and Modern Human landscape and climate from the Fumane cave sequence (Verona,
2070 Italy) using small mammal assemblages. *Quat. Sci. Rev.* 128, 1–13.
- 2071 Losacco, U., 1949. La glaciazione quaternaria dell'Appennino Settentrionale. *Riv. Geogr. It.* 56,
2072 90–152.
- 2073 Losacco, U., 1982. Gli antichi ghiacciai dell'Appennino settentrionale. Studio morfologico e
2074 paleogeografico. *Atti Società Naturalisti e Matematici Modena* 113, 1–24.
- 2075 Luciani, V., 1989. Stratigrafia sequenziale del Terziario nella Catena del Monte Baldo (Province di
2076 Verona e Trento). *Memorie di Scienze Geologiche dell'Università di Padova* XLI, 263–351.
- 2077 Luetscher, M., Boch, R., Sodemann, H., Spötl, C., Cheng, H., Edwards, R.L., Frisia, S., Hof, F.,
2078 Müller, W., 2015. North Atlantic storm track changes during the Last Glacial Maximum recorded
2079 by Alpine speleothems. *Nat. Comm.* 6(264).
- 2080 McLaughlan, M.S., Wright, R.A., Jiricka, R.D. 2010. Field guide to the ecosites of Saskatchewan's
2081 provincial forests. Saskatchewan Ministry of Environment, Forest Service. Prince Albert,
2082 Saskatchewan. 343 pp.
- 2083 Magyari, E.K., Kuneš, P., Jakab, G., Sümegi, P., Pelánkova, B., Schäbitz, F., Braun, M., Chytrý, M.
2084 2014. Late Pleniglacial vegetation in eastern-central Europe: Are there modern analogues in
2085 Siberia? *Quat. Sci. Rev.* 95, 60–79.
- 2086 Maier, A., Lehmkuhl, F., Ludwig, P., Melles, M., Schmidt, I., Shao, Y., Zeeden, C., Zimmerman,
2087 A., 2016. Demographic estimates of hunter-gatherers during the Last Glacial Maximum in Europe
2088 against the background of palaeoenvironmental data. *Quat. Int.* 425, 49-61.
- 2089 Maier, A., Zimmerman, A., 2017. Populations headed south? The Gravettian from a
2090 palaeodemographic point of view. *Antiquity* 91(357), 573–588.
- 2091 Makunina, N.I., 2016. Botanical and geographical characteristics of forest steppe of the Altai-Sayan
2092 mountain region. *Contemporary Problems of Ecology*. Maik Nauka Publishing / Springer SBM,
2093 9(3), pp. 342–348.
- 2094 Malez, M. 1979. Nalazišta paleolitskog i mezolitskog doba u Hrvatskoj. In: Benac, A. (Ed.),
2095 Praistorija jugoslavenskih zemalja, 1. Svjetlost, Sarajevo, pp. 227–276.
- 2096 Malez, M., 1987. Pregled paleolitičkih i mezolitičkih kultura na području Istre. *Izdanja Hrvatskog*
2097 *arheološkog društva* 11(2), 3–47.

- 2098 Malnar, N., 2017. Epigravetijenski nalazi pećine Vlakno. Unpublished Master Thesis. University of
2099 Zadar, Croatia.
- 2100 Marchetti, M., 2001. Fluvial, fluvioglacial and lacustrine forms and deposits. In: Castiglioni, G.B.,
2101 Pellegrini, G.B. (Eds.), Illustrative Notes of the Geomorphological Map of the Po Plain. Geogr.
2102 Fis. Din. Quat. (Suppl. 4), pp. 73–104.
- 2103 Mariani, G.S., Cremaschi, M., Zerboni, A., Zuccoli, L., Trombino, L., 2018. Geomorphological
2104 map of the Mt. Cusna Ridge (Northern Apennines, Italy): evolution of a Holocene landscape. *J.*
2105 *Maps* 14, 392–401.
- 2106 Martinez-Lamas, R., Toucanne, S., Debret, M., Riboulot, V., Deloffre, J., Boissier, A., Cheron, S.,
2107 Pitel, M., Bayon, G., Giosan, L., Soulet, G. 2020. Linking Danube River activity to Alpine Ice-
2108 Sheet fluctuations during the last glacial (ca. 33-17 ka BP): Insights into the continental signature
2109 of Heinrich Stadials. *Quat. Sci. Rev.* 229, 106-136.
- 2110 Martini, F., Colonese, A.C., Wilkens, B., 2003. Grotta della Serratura (Marina di Camerota - SA).
2111 La malacofauna dei livelli gravettiani ed epigravettiani. Considerazioni paleoecologiche. Atti 4°
2112 Convegno Nazionale di Archeozoologia. Quaderni Museo Archeologico Friuli Occidentale 6, 87-
2113 96.
- 2114 Maselli, V., Trincardi, F., Asioli, A., Ceregato, A., Rizzetto, F., Taviani, M., 2014. Delta growth
2115 and river valleys: the influence of climate and sea level changes on the South Adriatic shelf
2116 (Mediterranean Sea). *Quat. Sci. Rev.* 99, 146-163.
- 2117 Massari, F., Rosso, A., Radicchio, E., 1974. Paleocorrenti e composizione dei conglomerati
2118 tortoniano-messiniani compresi fra Bassano e Vittorio Veneto. *Memorie Istituto Geologia e*
2119 *Mineralogia Università di Padova* 31, 1-22.
- 2120 Massari, F., Grandesso, P., Stefani, C., Zanferrari, A., 1986. The Oligo-Miocene Molasse of the
2121 Veneto-Friuli region, Southern Alps. *Giornale di Geologia* 3(48/1-2), 235-255.
- 2122 Mathieson, I., Alpaslan-Roodenberg, S., Posth, C., Szecsenyi-Nagy, A., Rohland, N., Mallick, S.,
2123 Olalde, I., Broomandkhoshbacht, N., Candilio, F., Cheronet, O., et al., 2018. The genomic history
2124 of southeastern Europe. *Nature* 555(7695), 197-203.
- 2125 Matthews, J.A., 1992. The ecology of recently-deglaciated terrain. Cambridge University Press,
2126 Cambridge.
- 2127 Mauch-Lenardić, J., Oros Sršen, A., Radović, S., 2018. Quaternary fauna of the Eastern Adriatic
2128 (Croatia) with the special review on the Late Pleistocene sites. *Quat. Int.* 494,130-151.
- 2129 Meagher, M., 1989. Range expansion by bison of Yellowstone National Park. *J. Mammal.* 70, 670–
2130 675.

- 2131 Merxmüller, H., 1952. Untersuchungen zur Sippengliederung und Arealbildung in den Alpen. I.
2132 Jahrbuch des Vereins zum Schutze der Alpenpflanzen und Tiere, 17, 96–133.
- 2133 Merxmüller, H., 1953. Untersuchungen zur Sippengliederung und Arealbildung in den Alpen. II.
2134 Jahrbuch des Vereins zum Schutze der Alpenpflanzen und Tiere, 18, 138–158.
- 2135 Merxmüller, H., 1954. Untersuchungen zur Sippengliederung und Arealbildung in den Alpen. III.
2136 Jahrbuch des Vereins zum Schutze der Alpenpflanzen und Tiere, 19, 97–139.
- 2137 Mihailović, D., Mihailović, B., 2007. Considérations sur le Gravettien et l'Epigravettien ancien des
2138 Balkans de l'Ouest. *Paléo* 19, 115-130.
- 2139 Miko, S., Ilijanić, N., Hasan, O., Razum, I., Durn, T., Brunović, D., Papatheodorou, G., Bakrač, K.,
2140 Hajek-Tadesse, V., Crmarić, R., 2016. Late Quaternary evolution of lakes and submerged paleo-
2141 karst on the Eastern Adriatic. In: *Lake-Basin Evolution, RCMNS Interim Colloquium 2016*. 2016
2142 Croatian Geological Society Limnogeology, Zagreb.
- 2143 Miko, S., Ilijanić, N., Hasan, O., Razum, I., Durn, T., Brunović, D., Papatheodorou, G., Bakrač, K.,
2144 Hajek-Tadesse, V., Šparica Miko, M., Crmarić, R., 2017. Submerged karst landscapes of the
2145 eastern Adriatic. 5th Regional Scientific Meeting on Quaternary Geology Dedicated to
2146 Geohazards and Final Conference of the LoLADRIA Project "Submerged Pleistocene Landscapes
2147 of the Adriatic Sea".
- 2148 Miller, R., 2012. Mapping the expansion of the Northwest Magdalenian. *Quat. Int.* 272–273, 209-
2149 230.
- 2150 Miola, A., Gallio, S., 1998. Primi dati palinologici sulla sequenza di Galzignano del Pleistocene
2151 superiore - Colli Euganei (Padova - Nord Italia). *Atti della giornata di studi, Formigine, 18 maggio*
2152 1996.
- 2153 Miola, A., Albanese, D., Valentini, G., Corain, L., 2003. Pollen data for a biostratigraphy of LGM
2154 in the Venetian Po Plain. *Il Quaternario, Italian J. Quat. Sc.* 16(1), 21-25.
- 2155 Miola, A., Bondesan, A., Corain, L., Favaretto, S., Mozzi, P., Piovan, S., Sostizzo, I., 2006.
2156 Wetlands in the Venetian Po Plain (north-eastern Italy) during the Last Glacial Maximum:
2157 vegetation, hydrology, sedimentary environments. *Rev. Palaeob. Palyn.* 141, 53-81.
- 2158 Miracle, P.T., 1994-95. Diversification in epipalaeolithic subsistence strategies along the eastern
2159 adriatic coast: a simulation approach applied to zooarchaeological assemblages. *Atti Società*
2160 *Preistorica e Protostorica Friuli-Venezia Giulia*, 33-62.
- 2161 Miracle, P., 2007. The Late Glacial 'Great Adriatic Plain': 'Garden of Eden' or 'No Man's Land'
2162 during the Epipalaeolithic? A view from Istria (Croatia). In: Whallon, R. (Ed.), *Late Paleolithic*
2163 *Environments and Cultural Relations around the Adriatic. British Archaeological Reports*
2164 *International Series 1716*, Oxford, pp. 41-51.

- 2165 Miracle, P.T., Brajković, D., 2013. Pleistocene environments and Palaeolithic occupations at
2166 Šandalja Cave (Istria, Croatia): Results from new AMS 14C dates. Paper presented at the
2167 conference Geologija kvartara u Hrvatskoj. Zagreb, March 21- 23 2013.
- 2168 Momber, G., Tidbury, L., Satchell, J., 2016. The submerged lands of the Channel and North Sea:
2169 evidence of dispersal, adaptation and connectivity. In: Dupont, C., Marchand, G., (Eds.),
2170 Archaeology of maritime hunter-gatherers. From settlement function to the organization of the
2171 coastal zone. Société préhistorique française, Paris, Séances, 6, pp. 93-109.
- 2172 Monegato, G., Ravazzi, C., 2018. The Late Pleistocene multifold glaciation in the Alps: updates and
2173 open questions. *Al. Med. Quat.* 31, 225-229.
- 2174 Monegato, G., Ravazzi, C., Donegana M., Pini, R., Calderoni, G., Wick, L., 2007. Evidence of a
2175 two-fold glacial advance during the last glacial maximum in the Tagliamento end moraine system
2176 (eastern Alps). *Quat. Res.* 68, 284-302.
- 2177 Monegato, G., Pini, R., Ravazzi, C., Reimer, P., Wick, L., 2011. Correlating Alpine glaciation with
2178 Adriatic Sea-level changes through lake and alluvial stratigraphy. *J. Quat. Sci.* 26, 791–804.
- 2179 Monegato, G., Ravazzi, C., Culiberg, M., Pini, R., Bavec, M., Calderoni, G., Jež, J., Perego, R.,
2180 2015. Sedimentary evolution and persistence of open forests between the south-eastern fringe of
2181 the Alps and the Northern Dinarides during the Last Glacial Maximum. *Palaeo* 3(436), 23-40.
- 2182 Monegato, G., Scardia, G., Hajdas, I., Rizzini, F., Piccin, A., 2017. The Alpine LGM in the boreal
2183 icesheets game. *Nat. Sc. Rep.* 7(2078).
- 2184 Montet-White, A., 1996. *Le Paléolithique en ancienne Yougoslavie*. Jérôme Millon, Grenoble.
- 2185 Montoya, C., Peresani, M., 2005. Nouveaux éléments de diachronie dans l'Épigravettien récent des
2186 Préalpes de Vénétie. In: Bracco, J.P., Montoya, C. (Ed.), *Les systèmes techniques lithiques*
2187 *pendant le Tardiglaciaire autour de la Méditerranée Nord-occidentale*. Mémoires Société
2188 Préhistorique Française 40, pp.123-138.
- 2189 Montoya, C., Duches, R., Fontana, F., Peresani, M., Visentin, D., 2018, Peuplement tardiglaciaire et
2190 holocène ancien des Préalpes de la Vénétie (Italie Nord Orientale): éléments de confrontation. In:
2191 Averbouh, A., Bonnet-Jacquement, P., Cleyet-Merle, J. J. (Eds.), *L'Aquitaine à la fin des temps*
2192 *glaciaires - Aquitaine at the end of the Ice Age*. Les sociétés de la transition du Paléolithique final
2193 au début du Mésolithique dans l'espace Nord aquitain. *Paléo*, numéro spécial, pp. 193-202.
- 2194 Morales, J.I., Cebrià, A., Burguet-Coca, A., Fernández-Marchena, J.L., García-Argudo, G.,
2195 Rodríguez-Hidalgo, A., Soto, M., Talamo, S., Tejero, J.M., Vallverdú, J., Fullola, J.M., 2019. The
2196 Middle-to-Upper Paleolithic transition occupations from Cova Foradada (Calafell, NE Iberia).
2197 *PLoS ONE* 14(5): e0215832.

- 2198 Moreau, L., 2009. Geißenklösterle. Das Gravettien der Schwäbischen Alb im europäischen Kontext.
2199 Kerns Verlag. Tübingen.
- 2200 Mozzi, P., Ferrarese, F., Fontana, A., 2013. Integrating digital elevation models and stratigraphic
2201 data for the reconstruction of the post-LGM unconformity in the Brenta alluvial megafan (North-
2202 Eastern Italy). *Alp. Med. Quat.* 26, 41–54.
- 2203 Müller, U.C., Pross, J., Bibus, E., 2003. Vegetation response to rapid climate change in Central
2204 Europe during the past 140,000 yr based on evidence from the Füramoos pollen record. *Quat. Res.*
2205 59, 235-245.
- 2206 Mussi, M., 1990. Continuity and change in Italy at the Last Glacial Maximum. In: Soffer, O.,
2207 Gamble, C. (Eds.), *The World at 18.000 BP*. London: Unwyn Hyman Ltd, pp. 126-147.
- 2208 Mussi, M., 2001. *Earliest Italy. An overview of the Italian Paleolithic and Mesolithic*. New York:
2209 Kluwer Academic/Plenum Publishers.
- 2210 Mussi, M., Peresani, M., 2004, The peopling of northern Italy at the LGM. In: Antonioli, F., Vai,
2211 G.B. (eds.), *Climex Maps Italy. Explanatory Notes*, ENEA, pp. 59-60.
- 2212 Muttoni, G., Scardia, G., Kent, D.V., 2010. Early hominins in Europe: The Galerian migration
2213 hypothesis. *Quat. Sci. Rev.* 180, 1–29.
- 2214 Naudinot, N.A., Tomasso, A., Tozzi, C., Peresani, M., 2014. Changes in mobility patterns as a
2215 factor of ^{14}C date density variation in the Late Epigravettian of Northern Italy and Southeastern
2216 France. *J. Archaeol. Sc.* 52, 578-590.
- 2217 Nesci, O., Savelli, D., Troiani, F., 2012. Types and development of stream terraces in the Marche
2218 Apennines (central Italy): a review and remarks on recent appraisals. *Géomorph.* 2, 215-238.
- 2219 Nițu, E.C., Cârciumar, M., Nicolae, A., Cîrstina, O., Lupu, F.I., Leu, M., 2019. Mobility and social
2220 identity in the Mid Upper Paleolithic: New personal ornaments from Poiana Cireșului (Piatra
2221 Neamț, Romania). *PLoS ONE* 14(4), e0214932.
- 2222 Novak, A., Šmuc, A., Poglajen, S., Vrabec, M., 2020. Linking the high-resolution acoustic and
2223 sedimentary facies of a transgressed Late Quaternary alluvial plain (Gulf of Trieste, northern
2224 Adriatic). *Mar. Geol.* 419, 106061.
- 2225 Oliva, M., 2000. Some thoughts on pavlovian adaptations and their alternatives. In: Roebroeks, W.,
2226 Mussi, M., Svoboda, J., Fennema, K. (Eds.), *Hunters of the Golden Age: The Mid Upper*
2227 *Palaeolithic of Eurasia 30,000–20,000 BP*. Leiden, University of Leiden, pp. 219–227.
- 2228 Olive, M., (Ed.), 2017. *Campo delle Piane: un habitat de plein air épigravettien dans la Vallée du*
2229 *Gallero (Abruzzes, Italie centrale)*. École Française de Rome.
- 2230 Osole, F., 1974. Radiokarbonske datacije v slovenskem paleolitiku. *Situla* 14/15, 25-33.

- 2231 Otte, M., 1990. The northwestern european plain around 18000 BP. In: Soffer, O., Gamble, C.
2232 (Eds.), *The World at 18000 BP. High latitudes*, Unwin Hyman, London, 1, pp. 54-68.
- 2233 Palma di Cesnola, A., 1993. *Il Paleolitico superiore in Italia: introduzione allo studio*. Garlatti &
2234 Razzai, Firenze.
- 2235 Palma di Cesnola, A., 2001. *Le Paléolithique supérieur en Italie*. *Préhistoire d'Europe* 9, Jérôme
2236 Millon, Grenoble.
- 2237 Palma di Cesnola, A. (Ed.), 2004. *Paglicci. L'Aurignaziano e il Gravettiano antico*. Grenzi ed.,
2238 Foggia.
- 2239 Palma di Cesnola, A., 2006. *L'Aurignacien et le Gravettien ancien de la Grotte Paglicci au Mont*
2240 *Gargano*. *L'Anthropologie* 110(3), 355-370.
- 2241 Palombo, M.R., Mussi, M., 2006. Large mammal guilds at the time of the first human colonization
2242 of Europe: the case of the Italian Pleistocene record. *Quat. Int.* 149, 94-103.
- 2243 Paris, C., Deneuve, E., Fagnart, J.P., Coudret, P., Antoine, P., Peschaux, C., Lacarrière, J., Coutard,
2244 S., Moine, O., Guerin, G., 2017. Premières observations sur le gisement gravettien à statuettes
2245 féminines d'Amiens-Renancourt 1 (Somme). *Bulletin Société Préhistorique Française* 114, 423-
2246 444.
- 2247 Paronuzzi, P., Breda, M., Ghezzi, E., Reggiani, P., 2018a. La fauna tardo-Pleistocenica a
2248 macromammiferi del sito di Cava a Filo (indagini 2006-2016): tassonomia e quadro cronologico-
2249 paleoambientale. In: Lenzi, F., Nenzioni, G. (Eds.): *Aspetti speleogenetici, paleoambientali e*
2250 *paleoantropici dei Gessi Bolognesi*. *Memorie dell'Istituto Italiano di Speleologia, serie 2*. Istituto
2251 Italiano di Speleologia, pp. 145-169.
- 2252 Paronuzzi, P., Berto, C., Ghezzi, E., Thun Hohenstein, U., Massarenti, A., Reggiani, P., 2018b.
2253 Nota preliminare sulla sequenza UMG di ex Cava a Filo (Croara, BO): gli aspetti stratigrafico-
2254 sedimentari, paleontologici e antropici alla luce delle ultime indagini (2006-2016). In: Nenzioni
2255 G., Lenzi, F. (Eds.), *Geopaleontologia dei gessi Bolognesi. Nuovi dati sui depositi carsici del*
2256 *Pleistocene superiore*. *Memorie Istituto Italiano di Speleologia, S.II, Vol. XXXII*, pp. 131-144.
- 2257 Pelfini, M., Diolaiuti, G., Leonelli, G., Bozzoni, M., Bressan, N., Brioschi, D., Riccardi, A., 2012.
2258 The influence of glacier surface processes on the short-term evolution of supraglacial tree
2259 vegetation: The case study of the Miage Glacier, Italian Alps. *The Holocene* 22(8), 847-856.
- 2260 Pellegrini, C., Maselli, V., Cattaneo, A., Piva, A., Ceregato, A., Trincardi, F., 2015. Anatomy of a
2261 compound delta from the post-glacial transgressive record in the Adriatic Sea. *Mar. Geol.* 362,
2262 43-59.

- 2263 Pellegrini, C., Maselli, V., Gamberi, F., Asioli, A., Bohacs, K.M., Drexler, T.D., Trincardi, F.,
2264 2017. How to make a 350-m-thick lowstand systems tract in 17,000 years: the Late Pleistocene Po
2265 River (Italy) lowstand wedge. *Geology* 45, 327–330.
- 2266 Pellegrini, C., Asioli, A., Bohacs, K.M., Drexler, T., Feldman, H.R., Sweet, M.L., Maselli, V.,
2267 Rover, M., Gamberi, F., Dalla Valle, G., Trincardi, F., 2018. The late Pleistocene Po River
2268 lowstand wedge in the Adriatic Sea: Controls on architecture variability and sediment partitioning
2269 *Mar. Pet. Geol.* 96, 16-50.
- 2270 Percan, T., Komšo, D., Bekić, L., 2008. Ljubićeva pećina. *Hrvatski Arheološki Godišnjak* 5/2008,
2271 344-347.
- 2272 Peresani, M., 2006. Cultures et traditions du Paléolithique supérieur dans les régions nord-
2273 méditerranéennes. In: Sanchidrián, J.L., Márquez, A.M., Fullola Pericot, J.M. (Eds.), *La Cuenca*
2274 *Mediterránea durante el Paleolítico Superior (38.000-10.000 años)*, pp. 408-429. Fundación Cueva
2275 de Nerja, Nerja.
- 2276 Peresani, M., 2019. Settling a no-man's land. An up-dated review on the peopling of northern Italy
2277 at the Last Glacial Maximum. In: Schmidt, I., Cascalheira, J. (Eds.), *3rd International Conference*
2278 *on the Solutrean, 2017, Faro, Cambridge Scholars Publishing*, pp. 26-43.
- 2279 Peresani, M., Nicosia, C., 2015. Comparative study of two late Pleistocene sequences with
2280 paleosols and Aeolian deposits at the southern Alpine foreland. *Geogr. Fis. Dinam. Quat.* 38, 41-
2281 53.
- 2282 Peresani, M., Ravazzi, C., 2001. Le aree umide come archivi paleoambientali e archeologici tra
2283 tardiglaciale e Olocene antico: esempi e metodi di ricerca sul Cansiglio e alla Palù di Livenza. In
2284 (Visentini P., Vitri S. a cura di): *Il Palù alle sorgenti del Livenza: ricerca archeologica e tutela*
2285 *ambientale. Atti della Tavola Rotonda. Comunità Pedemontana del Livenza*. pp. 25-60.
- 2286 Peresani, M., Silvestrini, M., Gardin, S., 2005. Baracche, un site épigravettien récent dans la
2287 Dorsale de Cingoli, Marche. In: Askategi. *Miscellanea in memoria di Georges Laplace, Rivista di*
2288 *Scienze Preistoriche, Suppl. 1*, pp. 201-211.
- 2289 Peresani, M., Duches, R., Pastoors, A., 2011. Evidence of Gravettian frequentation around 30ky BP
2290 at the foot of the Friulian Dolomites. *Gortania. Geol., Paleont., Paletn.* 33, 93-100.
- 2291 Peresani, M., Romandini, M., Duches, R., Jéquier, C., Nannini, N., Pastoors, A., Picin, A., Schmidt,
2292 I., Vaquero, M., Weniger, G.C., 2014. New evidence for the Mousterian and Gravettian at Rio
2293 Secco Cave, Italy. *J. F. Archaeol.* 39(4), 401-416.
- 2294 Peresani, M., Ravazzi, C., Pini, R., Margaritora, D., Cocilova, A., 2018. Human settlement and
2295 vegetation-climate relationships in the Greenland Stadial 5 at the Piovesello site (Northern
2296 Apennines, Italy). *Quat. Res.* 90, 503-528.

- 2297 Peresani, M., Forte, M., Quaggiotto, E., Colonese, A.C., Romandini, M., Cilli, C., Giacobini, G.,
2298 2019. Marine shell exploitation in the Early Upper Palaeolithic. Re-examination of the shell
2299 assemblages from Fumane Cave (NE Italy). *PaleoAnthropol.* 2019, 64-81.
- 2300 Perhoč, Z., 2009. Sources of chert in Middle Dalmatia. Supplying raw material to prehistoric lithic
2301 industries. In: Forenbaher, S. (Ed.), *A Connecting Sea. Maritime Interaction in Adriatic*
2302 *Prehistory*. BAR International Series 2037, Archaeopress, Oxford, pp. 25–46.
- 2303 Perhoč, Z., 2020. Rohmaterial für die Produktion von Steinartefakten im Spätjungpaläolithikum,
2304 Mesolithikum und Neolithikum Dalmatiens (Kroatien). PhD thesis on the Ruprecht-Karls-
2305 University of Heidelberg, Germany.
- 2306 Perlès, C., 2018. Excavations at Franchthi Cave, Greece. *Ornaments and Other Ambiguous*
2307 *Artifacts from Franchthi, Volume 1, The Palaeolithic and the Mesolithic*. Indiana University Press.
- 2308 Petronio, C., Billia, E., Capasso Barbato L., Di Stefano, G., Mussi, M., Parry, S.J., Sardella, R.,
2309 Voltaggio, M., 1996. The Late Pleistocene fauna of Ingarano (Gargano, Italy): Biochronological,
2310 Palaeoecological, Palaeoethnological and Geochronological implications. *Boll. Soc. Paleontol. I.*
2311 34(3), 333-339.
- 2312 Piana, F., Fioraso G., Irace, A., Mosca, P., d’Atri, A., Barale, L., Falletti, P., Monegato, G., Morelli,
2313 M., Tallone, S., Vigna, G.B., 2017. Geology of Piemonte Region (NW Italy, Alps-Apennines
2314 junction zone). *J. Maps* 13(2), 395-405.
- 2315 Picotti, V., Pazzaglia, F.J., 2008. A new active tectonic model for the construction of the Northern
2316 Apennines mountain front near Bologna (Italy). *J. Geoph. Res.* 113, B08412.
- 2317 Pikelj, K., Juračić, M., 2013. Eastern Adriatic Coast (EAC): Geomorphology and Coastal
2318 Vulnerability of a Karstic Coast. *J. Coastal Res.* 29, 944-957.
- 2319 Pini R., Ravazzi C., Donegana M., 2009. Pollen stratigraphy, vegetation and climate history of the
2320 last 215 ka in the Azzano Decimo core (plain of Friuli, north-eastern Italy). *Quat. Sci. Rev.* 28,
2321 1268-1290.
- 2322 Pini, R., Ravazzi, C., Reimer, P.J., 2010. The vegetation and climate history of the last glacial cycle
2323 in a new pollen record from Lake Fimon (southern Alpine foreland, N-Italy). *Quat. Sci. Rev.*
2324 29(23), 3115-3137.
- 2325 Plumb, G.E., White, P.J., Coughenour, M.B., Wallen, R.L., 2009. Carrying capacity, migration, and
2326 dispersal in Yellowstone bison. *Biol. Conserv.* 142 (11), 2377–2387.
- 2327 Polšak, A., 1970. Osnovna geološka karta SFRJ 1: 100.000, tumač za list Pula. Zagreb: Institut za
2328 geološka istraživanja; Ljubljana: Geološki zavod (1963). Beograd: Savezni geološki zavod.
- 2329 Polšak, A., Šikić, D., 1973. Osnovna geološka karta SFRJ 1:100.000, tumač za list Rovinj. Zagreb:
2330 Institut za geološka istraživanja (1963). Savezni geološki zavod, Beograd.

- 2331 Posth, C., Renaud, G., Mittnik, A., Drucker, D.G., Rougier, H., Cupillard, C., Valentin, F.,
2332 Thevenet, C., Furtwängler A., Wißing, C., Francken, M., Malina, M., Bolus, M., Lari, M., Gigli,
2333 E., Capecchi, G., Crevecoeur, I., Beauval, C., Flas, D., Germonpré, M., van der Plicht, J.,
2334 Cottiaux, R., Gély, B., Ronchitelli, A., Wehrberger, K., Grigorescu, D., Svoboda, J., Semal, P.,
2335 Caramelli, D., Bocherens, H., Harvati, K., Conard, N.J., Haak, W., Powell, A., Krause, J., 2016.
2336 Pleistocene Mitochondrial Genomes Suggest a Single Major Dispersal of Non-Africans and a Late
2337 Glacial Population Turnover in Europe. *Curr. Biol.* 26, 827-833.
- 2338 Premoli Silva, I., Sliter, W.V., 1995. Cretaceous planktonic foraminiferal biostratigraphy and
2339 evolutionary trends from the Bottaccione section, Gubbio, Italy. *Palaeontographia Italica* 82, 1-89.
- 2340 Premoli Silva, I., Sliter, W., 2002. International School of Planktonic Foraminifera, 1° course:
2341 Cretaceous, Perugia, 18–22 february 2002. Milano: Centro Stampa XBS
- 2342 Radović, S., 2015. Lov u paleolitiku i mezolitiku: arheozoološka analiza velikih sisavaca iz špilje
2343 Zale. In: Vukosavljević, N., Karavanić, I. (Eds.), *Arheologija špilje Zale. Od paleolitičkih lovaca*
2344 *skupljača do rimskih osvajača*. Katedra Čakavskog sabora Modruše, Modruš, pp. 119-156.
- 2345 Rasmussen, S.O., Bigler, M., Blockley, S.P., Blunier, T., Buchardt, S.L., Clausen, H.B., Cvijanovic,
2346 I., Dahl-Jensen, D., Johnsen, S.J., Fischer, H., 2014. A stratigraphic framework for abrupt climatic
2347 changes during the Last Glacial period based on three synchronized Greenland ice-core records:
2348 refining and extending the INTIMATE event stratigraphy. *Quat. Sc. Rev.* 106, 14-28.
- 2349 Ravazzi C., Vescovi, E., 2009. Le testimonianze fossili della riforestazione del Cansiglio al termine
2350 dell'ultima glaciazione. In (Marco Peresani & Cesare Ravazzi eds.): "Le foreste dei cacciatori
2351 paleolitici". *Suppl. Bollettino Società Naturalisti Silvia Zenari, Pordenone*, pp. 65-96.
- 2352 Ravazzi C., Orombelli G., Tanzi G., & Climex group, 2004. An outline of the flora and vegetation
2353 of Adriatic basin (Northern Italy and eastern side of the Apennine) during the Last Glacial
2354 Maximum. In (Antonioli F. & Vai G.B. eds.): *Litho-paleoenvironmental maps of Italy during the*
2355 *Last Two Climatic Extremes. Explanatory Notes. 32nd International Geological Congress,*
2356 *Firenze*, pp. 15-20.
- 2357 Ravazzi, C., Peresani, M., Pini, R., Vescovi, E., 2007. Il Tardoglaciale nelle Alpi Italiane e in
2358 Pianura Padana. *Evoluzione stratigrafica, storia della vegetazione e del popolamento antropico*. *It.*
2359 *J. Quat. Sci.* 20(2), 163-184.
- 2360 Ravazzi, C., Badino, F., Marsetti, D., Patera, G., Reimer, P.J., 2012. Glacial to paraglacial history
2361 and forest recovery in the Oglio glacier system (Italian Alps) between 26 and 15 kyr cal BP. *Quat.*
2362 *Sci. Rev.* 58, 146-161.

- 2363 Ravazzi, C., Pini, R., Badino, F., De Amicis, M., Londeix, L., Reimer, P.J., 2014. The latest LGM
2364 culmination of the Garda Glacier (Italian Alps) and the onset of glacial termination. Age of glacial
2365 collapse and vegetation chronosequence. *Quat. Sci. Rev.* 105, 26-47.
- 2366 Ravazzi, C., Garozzo, L., Deaddis, M., De Amicis, M., Marchetti, M., Pini, R., Vezzoli, G., Zanchi,
2367 A., 2018. Palaeoenvironment and vegetation history in the Central Po Plain (Northern Italy)
2368 between 33 – 30 ka cal BP under the impact of millennial climate change. *Alp. Medit. Quat.* 31,
2369 93-97.
- 2370 Ravazzi, C., Badino, F., Perego, R., Bertuletti, P., De Amicis, M., Deaddis, M., Garozzo, L.,
2371 Novellino, M.D., Pini, R., 2020. Birch-sedge communities, forest withdrawal and flooding at the
2372 beginning of Heinrich Stadial 3 at the southern Alpine foreland. *Review of Palaeobotany and*
2373 *Palynology* 280, 104276.
- 2374 Reimer, P.J., Bard, E., Bayliss, A., Beck, J.W., Blackwell, P.G., Bronk Ramsey, C., Buck, C.E.,
2375 Cheng, H., Edwards, R.L., Friedrich, M., Grootes, P.M., Guilderson, T.P., Haflidason, H., Hajdas,
2376 I., Hatte, C., Heaton, T.J., Hogg, A.G., Hughen, K.A., Kaiser, K.F., Kromer, B., Manning, S.W.,
2377 Niu, M., Reimer, R.W., Richards, D.A., Scott, E.M., Southon, J.R., Turney, C.S.M., van der
2378 Plicht, J., 2013. IntCal13 and MARINE13 radiocarbon age calibration curves 0e50 000 years
2379 calBP. *Radiocarbon* 55 (4), 1869–1887.
- 2380 Richards, M.P., Karavanić, I., Pettitt, P., Miracle, P., 2015. Isotope and faunal evidence for high
2381 levels of freshwater fish consumption by Late Glacial humans at the Late Upper Palaeolithic site
2382 of Šandalja II, Istria, Croatia. *J. Archaeol. Sci.* 61, 204-212.
- 2383 Riedel, A., 1980. Il cavallo della grotta Tilde. *Atti Museo civico Naturale di Trieste.* 32(1), 19-110.
- 2384 Robaszynski, F., Caron, M., 1995. Foraminifères planctoniques du Crétacé: commentaire de la
2385 zonation Europe-Mediterranee. *Bulletin Societè Géologique de France* 6, 681-692.
- 2386 Roebroeks, W., 2000. A marginal matter: the human occupation of northwestern Europe – 30,000 to
2387 20,000 years bp. In: Roebroeks, W., Mussi, M., Svoboda, J., Fennema, K. (Eds.), *Hunters of the*
2388 *Golden Age: The Mid Upper Palaeolithic of Eurasia 30,000–20,000 BP.* Leiden, University of
2389 Leiden, pp. 271–280.
- 2390 Romandini, M., Nannini, N., 2012. Epigravettians hunters in the territory of the bear of caves: The
2391 case of Covolo Fortificato di Trene (Vicenza, Italy). *Anthropologie* 116, 39–56.
- 2392 Romandini, M., Bertola, S., Nannini, N., 2015. Nuovi dati sul Paleolitico dei Colli Berici: risultati
2393 preliminari dello studio archeozoologico e delle materie prime litiche della Grotta del Buso
2394 Doppio del Broion (Lumignano-Longare, VI). *Atti della XLVIII Riunione Scientifica dell’IIPP,*
2395 pp. 25-31.

- 2396 Ronchi, L., Fontana, A., Correggiari, A., Asioli, A., 2018. Late Quaternary incised and infilled
2397 landforms in the shelf of the northern Adriatic Sea (Italy). *Mar. Geol.* 405, 47–67.
- 2398 Roos, C.I., Zedeño, M.N., Hollenback, K.L., Erlick, M.M.H., 2018. Indigenous impacts on North
2399 American Great Plains fire regimes of the past millennium. *PNAS*, 115(32), 8143–8148.
- 2400 Rossato, S., Monegato, G., Mozzi, P., Cucato, M., Gaudio, B., Miola, A., 2013. Late Quaternary
2401 glaciations and connections to the piedmont plain in the prealpine environment: the middle and
2402 lower Astico Valley (NE Italy). *Quat. Int.* 288, 8-24.
- 2403 Rossato, S., Mozzi, P., 2016. Inferring LGM sedimentary and climatic changes in the southern
2404 Eastern Alps foreland through the analysis of a 14C ages database (Brenta megafan, Italy). *Quat.*
2405 *Sci. Rev.*, 148, 115–127.
- 2406 Rossato, S., Carraro, A., Monegato, G., Mozzi, P., Tateo, F., 2018. Glacial dynamics in pre-Alpine
2407 narrow valleys during the Last Glacial Maximum inferred by lowland fluvial records (northeast
2408 Italy). *Earth Surf. Dyn.* 6, 809-828
- 2409 Rousseau, D.D., Derbyshire, E., Antoine, P., Hatté, C., 2018. European Loess Records. Reference
2410 Module in Earth Systems and Environmental Sciences, 1-17.
- 2411 Ruiz-Redondo, A., Komšo, D., Garate Maidagan, D., Moro-Abadía, O., González-Morales, M.R.,
2412 Jaubert, J., Karavanić, I. 2019. Expanding the horizons of Palaeolithic rock art: the site of
2413 Romualdova Pećina. *Antiquity* 93 (368), 297-312.
- 2414 Sala, B., 2001. Le faune e gli ambienti del Ferrarese nel passato. In: Chiappini, A. (Ed.), *Storia di*
2415 *Ferrara, Volume I° - Territorio e preistoria*. Corbo Editore, Ferrara, pp. 56-73.
- 2416 Sala, B., 2004. Large Mammals of the LGM. In: Antonioli, F., Vai, G.B. (Eds.), *Climex Maps Italy*
2417 – explanatory notes, pp. 47-48.
- 2418 Sala, B., 2007. Mammalofaune Tardoglaciali dell'Italia continentale. In: Martini, F. (Ed.), *L'Italia*
2419 *tra 15.000 e 10.000 anni fa - cosmopolitismo e regionalità nel Tardoglaciale*, pp. 21-38.
- 2420 Sala, B., Gallini, V., 2002. La steppa-taiga a Mammut e Rinoceronti lanosi di Settepolesini - Il
2421 popolamento faunistico e gli ambienti di pianura durante l'Ultimo Glaciale. *Studi di*
2422 *Geomorfologia Zoologia e Paleontologia nel Ferrarese*, 39-45.
- 2423 Sala, B., Marchetti, M., 2006. The Po Valley floodplain (Northern Italy): a transitional area between
2424 two zoogeographical areas during the Late Neogene and Quaternary. *Courier Forsch., Inst.*
2425 *Senckenberg* 256, 321-328.
- 2426 Santantonio, M., Carminati, E., 2011. Jurassic rifting evolution of the Apennines and southern Alps
2427 (Italy): parallels and differences. *Geol. Soc. Am. Bull.* 123 (3-4), 468-484.
- 2428 Sarıkaya, M.A., Stepišnik, U., Žebre, M., Çiner, A., Yıldırım, C., Vlahović, I., Tomljenović, B., ·
2429 Matoš, B., Wilcken, K.M., 2020. Last glacial maximum deglaciation of the Southern Velebit Mt.

- 2430 (Croatia): insights from cosmogenic ^{36}Cl dating of Rujanska Kosa. *Mediterranean Geoscience*
2431 *Reviews*.
- 2432 Šćavničar, B., Šćavničar, S., Šušnjara, A., 1984. Vulkano-sedimentni srednji trijas u području
2433 potoka Suvaja, Svilaja pl., Vanjski Dinaridi. *Prirodoslovna istraživanja* 49, *Acta Geologica* 14(2),
2434 35–82/1–48.
- 2435 Scheer, A., 2000. The Gravettian in Southwest Germany: stylistic features, raw material resources
2436 and settlement patterns. In: Roebroeks, W., Mussi, M., Svoboda, J., Fennema, K. (Eds.), *Hunters*
2437 *of the Golden Age: The Mid Upper Palaeolithic of Eurasia 30,000–20,000 BP*. Leiden, University
2438 of Leiden, pp. 271–280.
- 2439 Schettino, A., Turco, E., 2011. Tectonic history of the western Tethys since the Late Triassic. *Geol.*
2440 *Soc. Am. Bull.* 123 (1-2), 89-105.
- 2441 Schmidt, R., Müller, J., Drescher-Schneider, R., Krisai, R., Szeroczyńska, K., Barić, A., 2000.
2442 Changes in lake level and trophy at Lake Vrana, a large karstic lake on the Island of Cres
2443 (Croatia), with respect to palaeoclimate and anthropogenic impacts during the last approx. 16,000
2444 years. *J. Limn.* 59(2), 113-130.
- 2445 Schmidt, R., Pugliese, N., Mueller, J., Szeroczyńska, K., Bogner, D., 2001. Palaeoclimate,
2446 vegetation and coastal lake development, from Upper Pleniglacial until early Holocene, in the
2447 northern Adriatic Valun Bay (Isle of Cres, Croatia). *Il Quaternario. Italian J. Quat. Sci.* 14(1), 61-
2448 78.
- 2449 Schmidt, R., Weckström, K., Lauterbach, S., Tessadri, R., Huber, K. 2012. North Atlantic climate
2450 impact on early late-glacial climate oscillations in the south-eastern Alps inferred from a multi-
2451 proxy lake sediment record. *J. Quat. Sci.* 27, 40–50.
- 2452 Schneider, R., 1975. Pollenanalytische Untersuchungen zur Kenntniss der spät- und postglazialen
2453 Vegetationsgeschichte am Südrand der Alpen zwischen Turin und Varese (Italien). – *Bot.Jb.Syst.*,
2454 100, 26–109.
- 2455 Schneider, R., Tobolski, K., 1985. Lago di Ganna - Late Glacial and Holocene environments of a
2456 lake in the Southern Alps. *Dissertationes Botanicae* 87: 229-271.
- 2457 Schönswetter, P., Stehlik, I., Holderegger, R. A., Tribsch, A., 2005. Molecular evidence for glacial
2458 refugia of mountain plants in the European Alps. *Mol. Ecol.* 14, 3547–3555.
- 2459 Šegvić, B., Kukoč, D., Dragičević, I., Vranjković, A., Brčić, V., Goričan, Š., Babajić, E., Hrvatović,
2460 H., 2014. New Record of Middle Jurassic Radiolarians and Evidence of Neotethyan Dynamics
2461 Documented in a Mélange from the Central Dinaridic Ophiolite

- 2462 Serandrei Barbero, R., Bertoldi, R., Canali, G., Donnici, S., Lezziero, A., 2005. Paleoclimatic
2463 record of the past 22,000 years in Venice (northern Italy): Biostratigraphic evidence and
2464 Chronology. *Quaternary International*, 140-141: 37-52.
- 2465 Serrano, E., Gómez-Lende, M., González-Amuchastegui, M.J., González-García, M., González-
2466 Trueba, J.G., Pellitero, R., Rico, I., 2015. Glacial chronology, environmental changes and
2467 implications for human occupation during the upper Pleistocene in the eastern Cantabrian
2468 Mountains. *Quat. Int.* 364, 22-34.
- 2469 Shackleton, J.C., van Andel, T.H., Runnels, C.N., 1984. Coastal paleogeography of the Central and
2470 Western Mediterranean during the last 125,000 years and its archaeological implications. *J. Field
2471 Archaeol.* 11, 307–315.
- 2472 Siddall, M., Rohling, E.J., Almogi-Labin, A., Hemleben, C., Meischner, D., Schmelzer, I., Smeed,
2473 D.A., 2003. Sea-level fluctuations during the last glacial cycle. *Nature* 423 853– 858.
- 2474 Siddall, M., Kaplan, M.R., Schaefer, J.M., Putnam, A., Kelly, M.A., Goehring, B., 2010. Changing
2475 influence of Antarctic and Greenlandic temperature records on sea-level over the last glacial cycle,
2476 *Quat. Sci. Rev.* 29, 410–423.
- 2477 Šikić, D., Pleničar, M., 1975. Osnovna geološka karta SFRJ 1:100.000, tumač za list Ilirska
2478 Bistrica. Zagreb: Institut za geološka istraživanja; Ljubljana: Geološki zavod (1967). Beograd:
2479 Savezni geološki zavod.
- 2480 Šikić, D., Polšak, A., 1973. Osnovna geološka karta SFRJ 1: 100.000, tumač za list Labin. Zagreb:
2481 Institut za geološka istraživanja; Ljubljana: Geološki zavod (1963). Beograd: Savezni geološki
2482 zavod.
- 2483 Šikić, K., Halamić, J., Belak, M., 2009. Ofiolitne stijene. In: I., Velić, I., Vlahović, Eds. Tumač
2484 Geološke karte Republike Hrvatske 1: 300 000, Hrvatski geološki institut, Zagreb, pp. 57–60.
- 2485 Sikora, M., Mihanović, H., Vilibić, I., 2014. Paleo-coastline of the Central Eastern Adriatic Sea,
2486 and Paleo-Channels of the Cetina and Neretva rivers during the last glacial maximum. *Acta
2487 Adriatica: International journal of Marine Sciences* 55(1), 3-18.
- 2488 Sikošek, B., 1971. Tumač geološke karte SFR Jugoslavije 1:500 000. Geološka karta SFRJ. 1:500
2489 000, list 1: Zagreb, 2: Novi Sad, 3: Sarajevo, 4: Beograd, 5: Dubrovnik, 6: Skopje. Beograd:
2490 Savezni geološki zavod.
- 2491 Silvestrini, M., Peresani, M., Muratori, S., 2005a. Frequentazioni antropiche allo spartiacque
2492 appenninico nella fase antica del Paleolitico superiore: il sito di Fonte delle Mattinate (Altopiano
2493 di Colfiorito). In: *Atti della XXXVIII Riunione Scientifica - Preistoria e Protostoria delle Marche.*
2494 Istituto Italiano di Preistoria e Protostoria, Firenze, pp. 69-79.

- 2495 Silvestrini, M., Ferrari, S., Peresani, M., 2005b. La produzione laminare nella tradizione
2496 gravettiana: le officine litiche di Fosso Mergaoni (Valle dell'Esino). Atti XXXVIII Riunione
2497 Scientifica Istituto Italiano di Preistoria e Protostoria, 93-102.
- 2498 Silvestrini, M., Cancellieri, E., Peresani, M., 2008. Il sito di Madonna dell'Ospedale ai margini
2499 dell'Appennino Marchigiano nell'Epigravettiano antico. Osservazioni sulla produzione litica. In
2500 Mussi, M. (ed.), *Il Tardiglaciale in Italia. Lavori in corso*. British Archaeological Reports,
2501 International Series 1859, pp. 81-102.
- 2502 Simonet, A., 2011. La Pointe des Vachons: nouvelles approches d'un fossile directeur controversé
2503 du Gravettien à partir des exemplaires du niveau IV de la grotte d'Isturitz (Pyrénées-Atlantiques,
2504 France) et des niveaux 4 des abris 1 e 2 des Vachons (Charante, France). *Paléo* 22, 271-298.
- 2505 Simonet, A., 2013. Premier bilan des fouilles effectuées dans la Grotte de Ljubić (2008-2011)
2506 (mission archéologique Monaco-Croatie). *Bull. Mus. Anthr. Préhist. Monaco* 53, 93-102.
- 2507 Sinitsyn, A., 2015. Perspectives on the Palaeolithic of Eurasia: Kostenki and related sites. In: Sanz,
2508 N. (Ed), *Human Origin Sites and the World Heritage Convention in Eurasia*. World Heritage
2509 Papers, 41, HEADS Programme on Human Evolution 4, UNESCO, Volume I, pp. 163-189.
- 2510 Sliter, V., 1989. Biostratigraphic zonation for Cretaceous planktonic foraminifers examined in thin
2511 section. *J. Foram. Res.* 19 (1), 1-19.
- 2512 Soffer, O., Gamble, C. (Eds.), 1990. *The Worlds at 18000 BP. High latitudes*, Unwin Hyman,
2513 London, Volume 1.
- 2514 Sokač, B., 2009. Klastične i piroklastične naslage, srednji trijas. In: I., Velić, I., Vlahović, (Eds.),
2515 Tumač Geološke karte Republike Hrvatske 1: 300 000. Zagreb: Hrvatski geološki institut.
- 2516 Šošić Klindžić, R., Karavanić, I., Vukosavljević, N., Ahern, J.C.M., 2015. Smještaj, stratigrafija,
2517 kronologija i tijek iskopavanja špilje Zale. In: Vukosavljević, N., Karavanić, I. (Eds.), *Arheologija*
2518 *špilje Zale. Od paleolitičkih lovaca skupljača do rimskih osvajača*. Katedra Čakavskog sabora
2519 Modruše, Modruš, pp. 15-48.
- 2520 Soubrier, J., Gower, G., Chen, K., Richards, S.M., Llamas, B., Mitchell, K.J., Ho, S.Y.W.,
2521 Kosintsev, P., Lee, M.S.Y., Baryshnikov, G., Bollongino, R., Bover, P., Burger, J., Chivall, D.,
2522 Crégut-Bonnoure, E., Decker, J.E., Doronichev, V.B., Douka, K., Fordham, D.A., Fontana, F.,
2523 Fritz, C., Glimmerveen, J., Golovanova, L. V., Groves, C., Guerreschi, A., Haak, W., Higham, T.,
2524 Hofman-Kamińska, E., Immel, A., Julien, M.-A., Krause, J., Krotova, O., Langbein, F., Larson,
2525 G., Rohrlach, A., Scheu, A., Schnabel, R.D., Taylor, J.F., Tokarska, M., Tosello, G., van der
2526 Plicht, J., van Loenen, A., Vigne, J.-D., Wooley, O., Orlando, L., Kowalczyk, R., Shapiro, B.,
2527 Cooper, A., 2016. Early cave art and ancient DNA record the origin of European bison. *Nat.*
2528 *Comm.* 7, 13158.

- 2529 Srdoč, D., Sliepčević, A., Planinić, J., Obelić, B., Breyer, B., 1973. Rudjer Bošković radiocarbon
2530 measurements II. Radiocarbon 15(2), 435–441.
- 2531 Stefani, C., Fellin, M.G., Zattin, M., Zuffa, G.G., Dalmonte, C., Mancin, N., Zanferrari, A., 2007.
2532 Provenance and paleogeographic evolution in a multi-source foreland: the Cenozoic Venetian-
2533 Friulian Basin (NE Italy). J. Sedim. Res. 77, 867– 887.
- 2534 Stiner, M.C., 1999. Palaeolithic mollusc exploitation at Riparo Mochi (Balzi Rossi, Italy): food and
2535 ornaments from the Aurignacian through Epigravettian, Antiquity 73(282), 735-54.
- 2536 Straus, L.G., 1991. Southwestern Europe at the Last Glacial Maximum. Curr. Anthr. 32, 189-199.
- 2537 Svenning, J.C., Normand, S., Kageyama, M., 2008. Glacial refugia of temperate trees in Europe:
2538 insights from species distribution modelling. J. Ecol. 96, 1117-1127.
- 2539 Talamo, S., Peresani, M., Romandini, M., Duches, R., Jéquier, C., Nannini, N., Pastoors, A., Picin,
2540 A., Vaquero, M., Weniger, G.C., Hublin, J.J., 2014. Detecting human presence at the border of the
2541 northeastern Italian Pre-Alps. 14C dating at Rio Secco Cave as expression of the first Gravettian
2542 and the late Mousterian in the northern Adriatic region. PLoS ONE 9(4): e95376.
- 2543 Tallavaara, M., Luoto, M., Korhonen, N., Järvinen, H., Seppä, H., 2015. Human population
2544 dynamics in Europe over the last glacial maximum. P.N.A.S. USA 112 (27), 8232-8237.
- 2545 Tassoni, L., 2019. Gli ornamenti su conchiglia dell'Uluzziano e del Proto-Aurignaziano delle Grotte
2546 di Castelcivita e della Cala (SA): studio tassonomico, tafonomico e sperimentale. Corso di Laurea
2547 Magistrale in Quaternario, Preistoria e Archeologia, A.A. 2017-18.
- 2548 Temovski, M., Madarász, B., Kern, Z., Milevski, I., Ruzsáczay-Rüdiger, Z., 2018. Glacial
2549 geomorphology and Preliminary glacier reconstruction in the Jablanica mountain, Macedonia,
2550 central Balkan peninsula. Geosciences 8, 270.
- 2551 Terlato, G., Bocherens, H., Romandini, M., Nannini, N., Hobson, K.A., Peresani, M., 2019a.
2552 Chronological and Isotopic data support a revision for the timing of cave bear extinction in
2553 Mediterranean Europe. Hist. Biol. 31, 474-484.
- 2554 Terlato, G., Livraghi, A., Romandini, M., Peresani, M., 2019b. Large bovids on Neanderthal menu:
2555 exploitation of *Bison priscus* and *Bos primigenius* in northeastern Italy. J. Archaeol. Sci: Reports
2556 25, 129-143.
- 2557 Tinner, W., Hubschmid, P., Wehrli, M., Ammann, B., Conedera, M., 1999. Long-term forest fire
2558 ecology and dynamics in southern Switzerland. J. Ecol. 87(2), 273-289.
- 2559 Tomasso, A., 2017. L'Épigravettien: variabilité diachronique et géographique. In: Olive, M. (ed.),
2560 Campo delle Piane: un habitat de plein air épigravettien dans la Vallée du Gallero (Abruzzes,
2561 Italie centrale). École Française de Rome, pp. 13-21.

- 2562 Toucanne, S., Soulet, G., Freslon, N., Jacinto, R.S., Dennielou, B., Zaragosi, S., Eynaud, F.,
2563 Bourillet, J.F., Bayon, G., 2015. Millennial-scale fluctuations of the European Ice Sheet at the end
2564 of the last glacial, and their potential impact on global climate. *Quat. Sci. Rev.* 123, 113-133.
- 2565 Trincardi, F., Argnani, A., Correggiari, A., 2011. Note illustrative della Carta Geologica dei Mari
2566 Italiani alla scala 1:250.000, Foglio NL 33-7 "Venezia". S.EL.CA., Firenze, 151 pp., 2 maps.
- 2567 Valladas, H., Quiles, A., Delque-Kolic, M., Kaltnecker, E., Moreau, C., Pons-Branchu, E., Vanrell,
2568 L., Olive, M., Delestre, X., 2017. Radiocarbon dating of the decorated Cosquer Cave (France).
2569 *Radiocarbon* 59(2), 621–633.
- 2570 Van Andel, T.H., 1989. Late Quaternary sea-level changes and archaeology. *Antiquity* 63(241):
2571 733-745.
- 2572 Vanhaeren, M., d'Errico, F., 2006. Aurignacian ethno-linguistic geography of Europe revealed by
2573 personal ornaments. *J. Archaeol. Sc.* 33(8), 1105-1128.
- 2574 Velić, I., Vlahović, I., 2009. Pločasti i slojeviti vapnenci s rožnjacima - Lemeške naslage. In: Velić,
2575 I., Vlahović, I., (eds). *Tumač Geološke karte Republike Hrvatske 1: 300 000*. Zagreb: Hrvatski
2576 geološki institut, 50–51.
- 2577 Velichko, A.A., Zelikson, E.M., 2005. Landscape, climate and mammoth food resources in the East
2578 European Plain during the Late Paleolithic epoch. *Quat. Int.* 126–128, 137–151.
- 2579 Vercellotti, G., Alciati, G., Richards, M., Formicola, V., 2008. The Late Upper Paleolithic skeleton
2580 Villabruna 1 (Italy): A source of data on biology and behavior of a 14,000 year-old hunter. *J.*
2581 *Anthropol. Sci.* 86, 143–16.
- 2582 Verheul, J., Zickel, M., Becker, D., Willmes, C., 2015. LGM Major Inland Waters of Europe-GIS
2583 Dataset. *CRC806-Database*, 14.
- 2584 Vescovi, E., Ravazzi, C., Arpentini, E., Finsinger, W., Pini, R., Valsecchi, V., Wick, L., Ammann, B.,
2585 Tinner, W., 2007. Interactions between climate and vegetation during the Lateglacial period as
2586 recorded by lake and mire sediment archives in Northern Italy and Southern Switzerland. *Quat.*
2587 *Sci. Rev.* 26, 1650-1669.
- 2588 Villalba-Mouco, V., van de Loosdrecht, M.S., Posth, C., Mora, R., Martinez-Moreno, J., Rojo-
2589 Guerra, M., Salazar-Garcia, D.C., Royo-Guillen, J.I., Kunst, M., Rougier, H., Crevecoeur, I.,
2590 Arcusa-Magallón, H., Tejedor-Rodríguez, C., García-Martínez de Lagrán, I., Garrido-Pena, R.,
2591 Alt, K.W., Jeong, C., Schiffels, S., Utrilla, P., Krause, J., Haak, W., 2019. Survival of Late
2592 Pleistocene Hunter-Gatherer Ancestry in the Iberian Peninsula. *Curr. Biol.* 29, 1169-1177.
- 2593 Vlahović, I., Velić, I., 2009. Prominske naslage, eocen, oligocen. In: Velić, I., Vlahović, I., (Eds.),
2594 *Tumač Geološke karte Republike Hrvatske 1: 300 000*. Zagreb: Hrvatski geološki institut, pp. 79–
2595 80.

- 2596 Vujević, D., Parica, M., 2009. Jewelry and art of Vlakno cave. *Archaeologica Adriatica* 3(1), 23-34.
- 2597 Vukosavljević, N., 2012. Organizacija litičke proizvodnje lovačko-sakupljačkih zajednica na
2598 prijelazu iz pleistocena u holocen u Dalmaciji. PhD Thesis at the University of Zagreb.
- 2599 Vukosavljević, N., Karavanić, I., 2015. Kasnogornjopaleolitički i mezolitički ukrasi od probušenih
2600 morskih i slatkovodnih puževa iz špilje Zale. In: Vukosavljević, N., Karavanić, I. (Eds.),
2601 Arheologija špilje Zale. Od paleolitičkih lovaca skupljača do rimskih osvajača. Katedra
2602 Čakavskog sabora Modruše, Modruš, pp. 157-174.
- 2603 Vukosavljević, N., Karavanić, I., 2017. Epigravettian shouldered points in the Eastern Adriatic and
2604 its hinterland: Reconsidering their chronological position. *Acta Archaeologica carpathica* LII, 5-
2605 21.
- 2606 Vukosavljević, N., Perhoč, Z., Altherr, R., 2014. Pleistocene-Holocene transition in the Vlakno
2607 Cave on the island of Dugi otok (Dalmatia, Croatia) – lithic perspective. *Prilozi Instituta za*
2608 *arheologiju u Zagrebu* 31, 5-72.
- 2609 Vukosavljević, N., Perhoč, Z., Karavanić, I., 2015. Litički skup nalaza od lomljenog kamena iz
2610 špilje Zale: kasni gornji paleolitik i mezolitik. In: Vukosavljević, N., Karavanić, I. (Eds.),
2611 Arheologija špilje Zale. Od paleolitičkih lovaca skupljača do rimskih osvajača. Katedra
2612 Čakavskog sabora Modruše, Modruš, pp. 73-118.
- 2613 Wacha, L., Pavlakovic, S.M., Novothny, A., Crnjakovic, M., Frechen, M., 2011a. Luminescence
2614 dating of Upper Pleistocene loess from the Island of Susak in Croatia. *Quat. Int.* 234, 50–61.
- 2615 Wacha, L., Pavlakovic, S.M., Novothny, A., Frechen, M., Crnjakovic, M., 2011b. The loess
2616 chronology of the Island of Susak, Croatia. *Quat. Sci. J.* 60, 153–169.
- 2617 Walter, H., Breckle, S. W., 1986. *Ecological Systems of the Geobiosphere. 3 Temperate and Polar*
2618 *Zonobiomes of Northern Eurasia.* Springer, Berlin.
- 2619 Wegmann, K.W., Pazzaglia, F.J., 2009. Late Quaternary fluvial terraces of the Romagna and
2620 Marche Apennines, Italy: Climatic, lithologic, and tectonic controls on terrace genesis in an active
2621 orogen. *Quaternary Science Reviews* 28, 137-165.
- 2622 Weinstock, J. 2017. Zooarchaeology. In: Janković, I., Komšo, D., Mihelić, S., Ahern, J.C.M. (Eds.),
2623 The ARCHAEOOLIM Project. Archaeological investigations into the Late Pleistocene and Early
2624 Holocene of the Lim Channel. Zagreb: Arheološki Muzej u Zagrebu/Institut za
2625 antropologiju/Arheološki Muzej Istre.
- 2626 Wick, L., 1996. Late-glacial and early-Holocene palaeoenvironments in Brianza, N Italy. II
2627 *Quaternario. It. J. Quat. Sci.* 9(2), 653-660.
- 2628 Wick, L., 2000. Southern Alps. Excursion guide. XXIV Moorexkursion in Southern Alps (16 - 24
2629 September 2000). Institute of Plant Sciences - University of Bern (Switzerland).

- 2630 Wierer, U., 2013. Variability and standardization: The early Gravettian lithic complex of Grotta
2631 Paglicci, Southern Italy. *Quat. Int.* 288, 215-238.
- 2632 Willis, K.J., Rudner, E., Sümegi, P., 2000. The full-glacial forests of central and southeastern
2633 Europe. *Quat. Res.* 53, 203-213.
- 2634 Winterer, E.L., Bosellini, A. 1981. Subsidence and sedimentation on Jurassic passive continental
2635 margin, southern Alps, Italy. *AAPG Bulletin* 65, 394-421.
- 2636 Wirsig, C., Zasadni, J., Ivy-Ochs, S., Christl, M., Kober, F., Schl€uchter, C. 2016. A deglaciation
2637 model of the Oberhasli, Switzerland. *J. Quat. Sci.* 31, 46–59.
- 2638 Zangrossi, F., Delpiano, D., Cocilova, A., Ferrari, F., Balzani, M., Peresani M., 2019. 3D visual
2639 technology and close-range spatial analysis on the edge: an application to the reconstruction of a
2640 Paleolithic workshop. *J. Archaeol. Sci.: Reports* 28, 102045.
- 2641 Zasadni, J., Klapysa, P., 2014. The Tatra mountains during the Last Glacial Maximum *J. Maps*
2642 10(3), 440-456.
- 2643 Žebre, M., Stepišnik, U., 2014. Reconstruction of Late Pleistocene glaciers on Mount Lovćen,
2644 Montenegro. *Quat. Int.* 353, 225–235.
- 2645 Žebre, M., Stepišnik, U., 2015. Glaciokarst geomorphology of the northern Dinaric alps: Snežnik
2646 (Slovenia) and Gorski Kotar (Croatia). *J. Maps* 5, 873-881.
- 2647 Žebre, M., Stepišnik, U., Colucci, R.R., Forte, E., Monegato, G., 2016. Evolution of a karst polje
2648 influenced by glaciation: the Gomance piedmont polje (northern Dinaric Alps). *Geomorphology*
2649 257, 143–154.
- 2650 Zerboni, A., Trombino, L., Frigerio, C., Livio, F., Berlusconi, A., Michetti, A.M., Rodnight, H.,
2651 Spötl, C., 2015. The loess-paleosol sequence at Monte Netto: a record of climate change in the
2652 Upper Pleistocene of the central Po Plain, northern Italy. *J. Soils Sediments* 15, 1329–1350.
- 2653 Zerboni, A., Amit, R., Baroni, C., Coltorti, M., Ferrario, M.F., Fioraso, G., Forno, M.G., Frigerio,
2654 C., Gianotti, F., Irace, A., Livio, F., Mariani, G.S., Michetti, A.M., Monegato, G., Mozzi, P.,
2655 Orombelli, G., Perego, A., Porat, N., Rellini, I., Trombino, L., Cremaschi, M., 2018. Towards a
2656 map of the upper Pleistocene loess of the Po plain loess basin (northern Italy). *Alp. Medit. Quat.*
2657 31, 253-256.
- 2658 Zhambazhamts, B. and Bat, B. (1985) ‘The Atlas of the climate and ground water resources in the
2659 Mongolian People’s Republic. Goskomgidromet SSSR, GUGMS MNR, GUGK SSSR,
2660 Ulaanbaatar’.
- 2661 Zickel, M., Becker, D., Verheul, J., Yener, Y., Willmes C., 2016. Paleocoastlines GIS dataset.
2662 CRC806-Database. <https://doi.org/10.5880/SFB806.20>

2663 Ziggotti, S., 2007. Il contributo dell'analisi funzionale alla ricostruzione del sito tardogravettiano di
2664 Fosso Mergaoni (Ancona). Primi risultati emersi dallo studio di un campione di manufatti. Rivista
2665 di Scienze Preistoriche LVII, 83-90.

2666 Zilhão, J., 1997. O Paleolítico superior de Estremadura Portuguesa. Edições Colibri, Lisboa, Voll.1
2667 and 2.

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2670 **Tables captions**

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2672 **Table 1.** A frame of predicted ecological zones and summary of potential vegetation formations in
 2673 the Great Adriatic - Padanian Region (GAPR) during the LGM and early LG (30 - 16 ka cal BP).
 2674 The ecosystem classification here adopted relies on the recognition that ecosystem properties are
 2675 closely tied to both physical and biotic site factors (see e.g. McLaughlan et al., 2010). The
 2676 application of this approach to past environments embraces both the identification of predicting
 2677 abiotic factors, provided by Quaternary geology (see sections xxx in this paper) and the biodiversity
 2678 provided by a number of fossil palaeoecological sites. * - taxa documented by the pollen record; § -
 2679 taxa documented by the macrofossil record.

2680 Sites references: 1. Cerete (Ravazzi et al., 2012); 2. Piovesello (Peresani et al., 2018); 3. Lake
 2681 Alserio (Wick, 2000); 4. Lake Annone (Wick, 1996); 5. Azzano Decimo (Pini et al., 2009); 6.
 2682 Broion Cave (Cattani and Renault-Miskovsky, 1983); 7. Lago della Costa (Gubler et al., 2018); 8.
 2683 Lake Fimon (Pini et al., 2010); 9. Lake Ganna (Schneider and Tobolski, 1985); 10. Lake Origlio
 2684 (Tinner et al., 1999); 11. Paina Cave (Bartolomei et al., 1985); 12. Paul di Manerba (Ravazzi et al.,
 2685 2014); 13. Lago Piccolo di Avigliana (Finsinger et al., 2008); 14. Renče (Monegato et al., 2015);
 2686 15. Revine (Casadoro et al., 1976; Wick, 2000); 16. Trana (Schneider, 1975); 17. Cà Fornera (Miola
 2687 et al., 2003); 18. Casaletto Ceredano (Ravazzi et al., 2020); 19. Galzignano (Miola and Gallio,
 2688 1998); 20. Ghedi (Pini, unpublished data); 21. San Donà di Piave (Miola et al., 2003); 22. Venice
 2689 Lagoon (Serandrei-Barbero et al., 2005); 23. Lake Vrana (Schmidt et al., 2000); 24. Valun Bay
 2690 (Schmidt et al., 2001).

2691 **Table 2.** List of the Gravettian-Epigravettian sites and radiocarbon dates in the GAPR mentioned in
 2692 this work. Notes: Elev, elevation above modern sea level; Ty, type of site (OA - Open air, C - Cave,
 2693 RS - Rockshelter); CC, cultural complex (G – Gravettian, EE - early Epigravettian, LE - Late
 2694 Epigravettian, ND - not determinable); Mat, material (C - charcoal, B – bone, HB – human bone,
 2695 S+C sediment and charcoal particles); ETH-79368 date is from a cut-marked cave bear bone;
 2696 samples from Baracche were collected on the surface of the quarried deposits in association with
 2697 the lithic artifacts. Conventional ages are expressed in ¹⁴C years BP and are calibrated in IntCal 13
 2698 (Reimer et al., 2013.)

2699 **Table 3.** Main features (natural shape, color, microfacies and micropalaeontology) of the cherts
 2700 shown in the Figs. 7, 9 and 10; numbers in the first column are corresponding. See also Fig. 6 for
 2701 the stratigraphic position of the samples. Notes: U-M basin, Umbria-Marche basin; C-B basin,
 2702 Carnia-Belluno basin.

2703 **Table 4.** Summary of the evidence produced from this study and from previous petroarchaeological
 2704 analyses of Gravettian and Epigravettian assemblages in the GAPR. Notes: Ty, Type of site (OA -
 2705 Open air, C - Cave, RS - Rockshelter); CC, Cultural Complex (G – Gravettian, EE - early
 2706 Epigravettian, LE - Late Epigravettian, ND - not determinable);

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2709 **Figures captions**

2710

2711 **Figure 1.** Map of Europe with the largest continental shelves emerged during the Last Glacial
 2712 Maximum. 1. Doggerland/North Sea, English Channel and Bristol Channel; 2. Bay of Biscay and
 2713 France Atlantic Coast; 3. North-central Portugal Atlantic Coast; 4. Catalunya and Valencia Coasts;
 2714 5. Gulf of Lion; 6. Great Po Plain; 7. Northern Black Sea Coast (Sea of Azov and Chorne Sea); 8.
 2715 Other LGM emerged areas; 9. Scandinavian and British Islands ice sheets; 10. Mountain Glaciers;
 2716 11. Major rivers and lakes. Technical notes: Coordinate system ETRS89 / UTM zone 32N (EPSG
 2717 25832); Digital Elevation Model (base topography – Copernicus Land Monitoring Service (CLMS),
 2718 2019 and General Bathymetric Chart of the Oceans (GEBCO), 2019). Sea level drop at – 130 m
 2719 (Pellegrini et al., 2017; 2018). Scandinavian and British Islands ice sheets after Hughes et al. (2016)
 2720 at 22 ka. The mountain glaciers from Ehlers et al. (2011) with updated reconstructions in the Tatra
 2721 Mountains (Zasadni and Klapyta, 2014), Dinarides (Kuhleemann et al., 2009; Žebre and Stepišnik,
 2722 2014, 2015; Temovski et al., 2018), Pyrenees (Delmas, 2015), Cantabrian range (Serrano et al.,
 2723 2015). Alpine glaciers downloaded from <https://booksite.elsevier.com/9780444534477/> and
 2724 modified in the Italian side using updated reconstructions (Ravazzi et al., 2012; Monegato et al.,
 2725 2017; Gianotti et al., 2015; Ivy-Ochs et al., 2018; Rossato et al., 2013, 2018). Major European and
 2726 eastern European lakes and rivers after Toucanne et al. (2015) and Verheul et al. (2015), Adriatic
 2727 lakes (Miko et al., 2017) and rivers simplified from Maselli et al. (2014) (For interpretation of the
 2728 references to colour in this figure legend, the reader is referred to the Web version of this article).

2729 **Figure 2.** Palaeogeographic map of the Great Adriatic-Po Region (GAPR) with the Great Po Plain
 2730 (GPP) composed by the Po Plain (PP), the Adriatic Plain (AP) and the Venetian - Friulian Plain
 2731 (VFP) in the Last Glacial Maximum. Main physiographic units at the last glacier culmination in the
 2732 piedmont at the southern side of the Alps, 26 to 22 ka cal BP (LGM p.p.). Key: 1. Glaciers
 2733 (according to Ehlers et al. 2011 with updatings by Ravazzi et al., 2012; Monegato et al., 2017;
 2734 Gianotti et al., 2015; Ivy-Ochs et al., 2018; Rossato et al., 2013, 2018; Braakhekke et al., 2020 in

2735 the sectors between the Dora Riparia and the Brenta valley outlets; Garda glacier, GG; Tagliamento
 2736 glacier, TG); 2. Lakes (based on Miko et al., 2017); 3. megafan bodies above the current sea level
 2737 (B Mgf, Brenta megafan; P Mgf, Piave megafan; T Mgf, Tagliamento megafan; Fontana et al.,
 2738 2008, 2014a); 4. megafan bodies sunken under the current sea level; 5. Upper proximal megafan
 2739 belt; 6. Po River floodplain (Amorosi et al. 2017, [http://www.sinanet.isprambiente.it/it/sia-
 2741 ispra/download-mais/complessi-idrogeologici](http://www.sinanet.isprambiente.it/it/sia-

 2740 ispra/download-mais/complessi-idrogeologici)); 7. Po River delta (Pellegrini et al., 2018); 8, stable
 2742 surfaces supporting deeply weathered soils and loess. These surfaces belong to the following main
 2743 physiographic units: ancient, terraced alluvial units; hills emerging from the plain (BH, Berici
 Hills); karstic plateaux at low elevation; 9, DEM color scale -130 – 4.808.

2744 Technical note. Coordinate system ETRS89 / UTM zone 32N (EPSG 25832); Digital Elevation
 2745 Model (base topography – Copernicus Land Monitoring Service (CLMS), 2019 and General
 2746 Bathymetric Chart of the Oceans (GEBCO), 2019). Sea level drop at – 130 m (Pellegrini et al.,
 2747 2015; 2017; 2018). The mountain glaciers (pale blue) from Ehlers et al. (2011). Dinarides from
 2748 Žebre and Stepišnik (2015). Alpine glaciers downloaded from
 2749 <https://booksite.elsevier.com/9780444534477/> and modified in the Italian side using updated
 2750 reconstructions (Ravazzi et al., 2012; Monegato et al., 2017; Gianotti et al., 2015; Ivy-Ochs et al.,
 2751 2018; Rossato et al., 2018; Braakhekke et al., 2020). Adriatic lakes (Miko et al., 2017). Stable areas
 2752 (middle and lower Pleistocene alluvial deposits, aeolian sediments, Loess) (Zerboni et al., 2018;
 2753 Geological Map 1:50.000 Iseo, Bergamo, Vimercate sheets; Geomorphological Map of the Po Plain
 2754 (Giuliano et al., 1998), selected area with slope range 0-10% of Geological Map of Slovenia
 2755 1:1.000.000). Alluvial fans and megafans along the southern side of the Alps (Fontana et al.,
 2756 2014a). Alluvial fans along the northeastern side of the Apennine (Amorosi et al., 2017; Bruno et
 2757 al., 2018). Po river delta area (Pellegrini et al., 2018) and Po channel belt (Amorosi et al., 2017;
 2758 Bruno et al., 2018; Carta Complessi idrogeologici [http://www.sinanet.isprambiente.it/it/sia-
 2760 ispra/download-mais/complessi-idrogeologici](http://www.sinanet.isprambiente.it/it/sia-

 2759 ispra/download-mais/complessi-idrogeologici)). Gravelly sector of the plain (Castiglioni et al.,
 2761 1997). Distal plain. (For interpretation of the references to colour in this figure legend, the reader is
 2762 referred to the Web version of this article).

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2763 **Figure 3.** Map of the Great Adriatic-Po Region showing the location of Palaeobotanical,
 2764 Palaeontological and Palaeolithic sites mentioned in the text. Palaeobotanical sites: 1. Cerete; 2.
 2765 Piovesello (including the Piovesello Paleolithic site); 3. Lake Alserio; 4. Lake Annone; 5. Azzano
 2766 Decimo; 6. Grotta Broion (including the Riparo Broion and Grotta Buso Doppio Broion Paleolithic
 2767 sites); 7. Lago della Costa; 8. Lake Fimon; 9. Lake Ganna; 10. Lake Origlio; 11. Grotta Paina

2768 (including the Grotta Stria and Grotta Trene Paleolithic sites); 12. Paul di Manerba; 13. Lago
 2769 Piccolo di Avigliana; 14. Renče; 15. Revine; 16. Trana; 17. Cà Fornera; 18. Casaletto Ceredano; 19.
 2770 Galzignano; 20. Ghedi; 21. San Donà di Piave; 22. Venice Lagoon; 23. Lake Vrana; 24. Valun Bay;
 2771 Palaeontological sites: 25. Settepolesini; 26. Grotta Tilde; 27. Cava a Filo;
 2772 Palaeontological and Palaeolithic sites: 28. Bùs dei Lader; 29. Grotta Fumane; 30. Riparo Tagliente;
 2773 31. Grotta Rio Secco; 32. Ovčja Jama and Županov Spodmol; 33. Zala cave; 34. Abri Kontija 002,
 2774 Romualdova pećina and Pećina kod Rovinjskog Selo 1; 35. Šandalja II cave and Ljubićeva pećina;
 2775 36. Vlakno cave; 37. Fornace San Damiano; 38. Fonte delle Mattinate; 39. Fosso Mergaoni; 40.
 2776 Ponte di Pietra; 41. Madonna dell'Ospedale and Baracche; 42. Campo delle Piane. (For
 2777 interpretation of the references to colour in this figure legend, the reader is referred to the Web
 2778 version of this article).

2779 **Figure 4.** 3D ecographic sketch of the ecoclimatic gradient spanning the Kurai steppe and the
 2780 northern slope of the Chuya mountains, SW Altai, Russia, 50°12'48" N, 87°56'27" E. It provides a
 2781 modern analogue, predicted by palaeoecological data, for the elevational structure of the ecozones
 2782 at the southern fringe of the Alps during the LGM. (drawn on the Google Earth Satellite image,
 2783 June 2017; interpreted on the base of Blyakharchuk et al., 2008; Kuneš et al., 2008; Makunina,
 2784 2016; Badino et al., submitted; elaboration by the Lab. Palynology, CNR Milano).

2785 **Figure 5.** Selection of Epigravettian shouldered backed points (nn. 1 to 5) and *microgravettes* (nn.
 2786 6-7) from: 1, 2 and 7. Paina - Grottina Azzurra; 3. Buso Doppio Broion; 4 and 6. Trene; 5. Šandalja
 2787 II (from Broglio et al., 2009; Vukosavljević and Karavanić, 2017).

2788 **Figure 6.** Distribution of calibrated dates in the 35 – 15 ka interval reported in Table 2.

2789 **Figure 7.** Comparative stratigraphic sketches of the Apennines Umbria-Marche Basin and Southern
 2790 Alps Trento Plateau series with highlighted the distribution of the cherts. The numbers on the right
 2791 of the Umbria-Marche column resume the stratigraphic position of the archaeological and
 2792 geological samples shown in the Figs. 8, 10 and 11.

2793 **Figure 8.** Micrographs of Umbria-Marche Basin cherts from primary exposures. 1. Oligocene
 2794 Scaglia Cinerea; 2. Eocene Scaglia Rossa; 3. Middle Cretaceous Scaglia Bianca; 4. Middle
 2795 Cretaceous Marne a Fucoidi; 5-6. Lower Cretaceous Maiolica (scale bar = 1 mm; for interpretation
 2796 of the references to colour in this figure legend, the reader is referred to the Web version of this
 2797 article).

2798 **Figure 9.** Maps of the GAPR at different time intervals (32-29, 26-23, 23-19, 18-16 ka cal BP)
 2799 showing the simplified palaeogeographic units, the Gravettian - Epigravettian radiocarbon dated

2800 sites and the sites that produced indication of allochthonous chert provenance (black arrows). Key:
 2801 1, DEM color scale -130 – 4,808 m amsl; 2. Glaciers; 3. Lakes; 4. Upper proximal megafan belt; 5.
 2802 Po River floodplain; 6, Po River delta; 7, stable surfaces supporting deeply weathered soils and
 2803 loess. For details on references and explanations of the legend see figure 2 and section 2.1. For
 2804 discussion on the chronological frame and cultural attribution of each site see section 3.2. (For
 2805 interpretation of the references to colour in this figure legend, the reader is referred to the Web
 2806 version of this article).

2807 **Figure 9a.** Simplified map for the interval 32-29 ka cal BP. Sites: 2. Piovesello; 6. Grotta Broion
 2808 and Riparo Broion; 11. Paina; 31. Rio Secco; 34. Pećina kod Rovinjskog Sela 1; 38. Fonte delle
 2809 Mattinate.

2810 **Figure 9b.** Simplified map for the interval 26-23 ka cal BP. Sites: 11. Paina, Trene and Stria; 32.
 2811 Ovčja Jama (note that layer 4 is culturally attributed to the early Epigravettian); 35. Šandalja II
 2812 (note that layer C/d is culturally attributed to the early Epigravettian); 40. Ponte di Pietra.

2813 **Figure 9c.** Simplified map for the interval 23-19 ka cal BP2. Sites: 6. Riparo Broion and Buso
 2814 Doppio Broion; 11. Stria, Trene and Paina; 28. Büs dei Lader; 34. Romualdova; 35. Šandalja II; 36,
 2815 Vlakno; 39. Fosso Mergaoni; 40. Ponte di Pietra (note that these last two sites are culturally
 2816 attributed to the late Gravettian).

2817 **Figure 9d.** Simplified map of the eastern GAPR for the interval 18-16 ka cal BP. Sites: 30.
 2818 Tagliente; 33. Zala; 34. Romualdova; 35. Ljubičeva; 41. Baracche; 42. Campo delle Piane.

2819 **Figure 10.** Berici Hills (7-11) and Lessini Mountains (12). Micrographs of allochthonous cherts from
 2820 the Umbria-Marche Basin taken on Epigravettian artifacts: 7. Oligocene Scaglia Cinerea (Paina
 2821 Cave - Grottina Azzurra layer 6); 8. Eocene Scaglia Rossa (Paina - Grottina Azzurra layer 6); 9.
 2822 Eocene Scaglia Rossa (Trene, complex B); 10. Middle Cretaceous Marne a Fucoidi (Buso Doppio
 2823 del Broion, layer Rim); 11. Lower Cretaceous Maiolica (Paina - Sala Terminale layer 125); 12.
 2824 Middle Jurassic Calcari Diasprigni (Tagliente, SU 300) (scale bar = 1 mm; for interpretation of the
 2825 references to colour in this figure legend, the reader is referred to the Web version of this article).

2826 **Figure 11.** Istria. Micrographs of allochthonous cherts from the Umbria-Marche Basin (13-15) and
 2827 the Carnia-Belluno Basin (16-18) taken on Epigravettian artifacts: 13. Eocene Scaglia Rossa
 2828 (Šandalja II, layer C/d); 14. Eocene Scaglia Rossa (Romualdova pećina); 15. Lower Cretaceous
 2829 Maiolica (Šandalja II, layer C/d); 16. Lower Cretaceous Maiolica (Šandalja II, layer C/d); 17.
 2830 Middle Jurassic Soverzene (Šandalja II, layer C/d); 18. Triassic Buchenstein (Šandalja II, layer C/d)
 2831 (scale bar = 1 mm; for interpretation of the references to colour in this figure legend, the reader is
 2832 referred to the Web version of this article).

Site	Geography	Elev	Ty	CC	Context	Lab. ID	Mat	¹⁴ C age	Cal. age BP	Reference
Piovesello	Emilian Apennine	870	OA	G	7	LTL13257A	C	26020±80	30681 29899	Peresani et al., 2018
					7	LTL14195A	C	25650±100	30235 29444	Peresani et al., 2018
Büs dei Lader	Lombard Prealps	310	C	ND	infill	GrA-216	C	17040±80	20802 20301	Biagi, 2000
Riparo Tagliente	Lessini Plateau	226	RS	LE	13a alpha	LTL4441A	B	13986±60	17219 16687	Fontana et al., 2012
				LE	300	Lyon-10030	B	13920±80	17160 16555	Fontana et al., 2018
				LE	15-16	R-605a	C	13430±180	16761 15660	-- old date no ref.
				LE	15-16	R-605	C	13330±160	16537 15548	-- old date no ref.
					352	OxA-29834	B	13600±60	16638 16179	Soubrier et al., 2016
				LE	13a	Lyon-10031	B	13450±70	16438 15941	Fontana et al., 2018
				LE	10e (OL3)	OxA-3532	C	13270±170	16426 15371	-- old date no ref.
					10c (OL2)	OxA-3531	C	13070±170	16147 15176	-- old date no ref.
					13trincea	Lyon-10033	B	13250±80	16186 15684	Fontana et al., 2018
					13burial	OxA-10672	HB	13190±90	16149 15532	Gazzoni et al., 2013
Grotta Broion	Berici Hills	145	C	G	D	UtC-2694	B	24700±400	29656 27890	Broglio and Improta, 1995
				G	E	UtC-2693	B	25250±280	30150 28705	Broglio and Improta, 1995
Riparo Broion	Berici Hills	135	RS	G	1b	Utc-13320	C	28460±260	33220 31598	De Stefani et al., 2005
					1balfa	UtC-10504	C	27960±300	32702 31216	De Stefani et al., 2005
					1b - S1	UtC-10506	C	17830±100	21890 21282	De Stefani et al., 2005
					1c	UtC-13321	C	25860±200	30657 29532	De Stefani et al., 2005
Buso Doppio Broion	Berici Hills	135	C	EE	1tII	--	-	--	--	Romandini et al., 2015
				G	2-1tt.II-IV 1base	--	-	--	--	Romandini et al., 2015
Grotta Paina	Berici Hills	335	C	EE	5	ETH-79366	B	19686±54	23948 23489	Terlato et al., 2019a
				EE	6	UtC-2696	B	20120±220	24875 23660	Broglio and Improta, 1995
					6	UtC-2043	B	19430±150	23810 22985	Broglio and Improta, 1995
				G	7A	UtC-2697	B	20200±240	25040 23730	Broglio and Improta, 1995
Grotta Col de La Stria	Berici Hills	370	C	EE	2cl	LTL-2638A	C	16037±100	19609 19050	Romandini and Nannini, 2012
				EE	2cl	LTL-2639A	C	16802±90	20522 20017	Romandini and Nannini, 2012
					2base	LTL-2147A	B	19485±200	23780 23107	Romandini and Nannini, 2012
Grotta Trene	Berici Hills	360	C	EE	BI	UtC-2691	B	17640±140	21761 20930	Broglio and Improta, 1995
					BI	ETH-79368	B	19948±55	25476 22821	Terlato et al., 2019a
					BII	UtC-2692	B	18630±150	22909 22174	Broglio and Improta, 1995
Grotta Rio Secco	Carnic Prealps	580	C	G	6	Poz-41207	C	27080±230	31380 30807	Peresani et al., 2014

					6	Poz-41208	C	28300±260	32977 31471	Peresani et al., 2014
					6	MAMS-15906	C	28995±135	33609 32816	Talamo et al., 2014
					6	MAMS-15907	C	29390±135	32839 31735	Talamo et al., 2014
Fonte delle Mattinate	Marche Apennine	760	OA	G	B-27	--	C	28300±790	33964 31039	Silvestrini et al., 2005a
				G	C1	GU-9426	S+C	25930±325	30851 29414	Giaccio et al., 2004
Ponte di Pietra	Marche Apennine	225	OA	G	II, su 65	CRG-1018	C	19940±471	25273 22942	Lollini et al., 2005
					II, su 66	CRG-1019	C	18515±618	23934 20926	Lollini et al., 2005
Fosso Mergaoni	Marche Apennine	180	OA	G	4a2	UtC-11551	C	18160±240	22503 21389	Silvestrini et al., 2005b
Madonna dell'Ospedale	Marche Apennine		OA	EE	--	--	-	--	--	Silvestrini et al., 2008
Baracche	Marche Apennine	350	OA	LE	--	LTL169A	C	14920±95	18385 17896	Peresani et al., 2005
					--	LTL172A	C	14929±110	18431 17884	Peresani et al., 2005
Campo delle Piane – CDP 7	Abruzzi Preapennine	350	OA	LE	24	GifA-99158	C	14590±120	18055 17465	Olive, 2017
					24	GifA-100542	C	14810±120	18332 17713	Olive, 2017
Ovčja Jama	Karst	586	C	G	4	KN-48	C	19540±500	24856 22450	Osole, 1974
Zala	W mount. Croatia	270	C	LE	100	Beta-334806	B	14100±60	17414 16924	Šošić Klindžić et al., 2015
				LE	12	Beta-228734	B	13840±50	16986 16509	Karavanić et al., 2007
				LE	102	Beta-334805	B	13340±60	16250 15831	Šošić Klindžić et al., 2015
Abri Kontija 002	Istria	46	RS	G	--	--	-	--	--	Janković et al., 2015
Pećina kod Rovinjskog Sela 1	Istria	71	C	G	B	Poz-80127	B	26730±300	31290 30405	Unpublished (DK)
Ljubićeva pećina	Istria	170	C	LE	D (4)	Beta-249371	C	13230±70	16136 15676	Percan et al., 2009 Simonet, 2013
Romualdova pećina	Istria	110	C	EE	2	Beta-465338	C	13970±50	17174 16692	Ruiz-Redondo et al., 2019
					2	OxA-36127	C	14250±80	17592 17099	Ruiz-Redondo et al., 2019
Šandalja II	Istria	70	C	EE	C/d	Z-193	C	20750±400	25840 24085	Srdoč et al., 1973
Vlakno	Dugi otok Island	38	C	EE	32	Beta-302247	C	16330±70	19955 19515	Cvitkušić et al., 2018

Figure	Formation	Age	Provenance	Nat. shape	Color	Microfacies and micropalaeontology
8.1, 10.7	Scaglia Cinerea	Oligocene	U-M basin	nodules	grey to black	Pelagic cherty limestone with radiolarians and planktic foraminifers (<i>Globigerina</i> and <i>Pseudohastigerina</i>)
8.2, 10.8-9, 11.13-14	Scaglia Rossa	Eocene	U-M basin	nodules	reddish brown	Pelagic cherty limestone with radiolarians and planktic foraminifers (<i>Globigerina</i> , <i>Morozovella</i> and <i>Acarinina</i>)
8.4, 10.10	Marne a Fucoidi	Aptian	U-M basin	layers	green	Pelagic cherty marly limestone with radiolarians and bad preserved pre-globotruncanids and planomalinids
8.5-6, 10.11, 11.15	Maiolica	Valanginian-Barremian	U-M basin	nodules and layers	grey	Very fine texture pelagic cherty limestone with radiolarians and limestone remains
10.12	Calcarei Diaspri	Kimmeridgian-Tithonian	U-M basin	nodules and layers	dark red to violet	Pelagic cherty limestone with radiolarians, <i>Saccocoma</i> and <i>Aptici</i>
11.16	Maiolica	Valanginian-Barremian	C-B basin	nodules and layers	grey	Pelagic cherty limestone with resedimented radiolarians and sponge spicules
11.17	Soverzene	Hettangian-Pliensbachian	C-B basin	layers	dark grey to black	Bituminous cherty dolomitic limestones with sponge spicules and radiolarians
11.18	Buchenstein	Ladinian	C-B basin	layers	grey to green	Pelagic cherty limestone with volcanoclastic detrital inputs and bad preserved radiolarians
8.3	Scaglia Bianca	Cenomanian	U-M basin	nodules and layers	grey to black	Laminated cherty marly limestone rich in organic matter, radiolarians and planktic foraminifers (<i>Rotalipora</i>)
8.4	Marne a Fucoidi	Albian	U-M basin	layers	green	Pelagic marly limestone with radiolarians and well preserved planktic foraminifers (<i>Planomalina</i>)

Table 3

Site	CC	Geographic location	Provisioning Area	PD	Range	Reference
Piovesello	G	Emilian Apennine	Nure valley	5-15	5-300	Peresani et al., 2018
			Provence	300		
Fumane	G	Venetian Prealps	Lessini Plateau	5-15	5-15	This study
Grotta Broion Riparo Broion	G	Venetian Prealps	Berici Hills	5-15	5-50	Bertola et al., 2018
			Lessini Plateau	25-50		
Rio Secco	G	Carnic Prealps	Carnic and Friulan Prealps	5-50	5-50	This study
Abri Kontija 002	G	Istria	--	--	--	--
Pećina Kod Rovinjskog Sela 1	G	Istria	--	--	--	--
Fonte delle Mattinate	G	Marche Apennine	Umbria-Marche Apennine	0-15	0-50	Silvestrini et al., 2005a; Cancellieri, 2018
			High Tiberine valley	25-50		
Ponte di Pietra	G	Marche Apennine	Umbria-Marche Apennine	0-15	0-15	Lollini et al. 2005; this study
Fosso Mergaoni	G	Marche Apennine	Umbria-Marche Apennine	0-15	0-15	Silvestrini et al. 2005b; Cancellieri, 2015
Paina, layer 7	G	Venetian Prealps	Berici Hills	5-15	5-270	Broglia et al., 2009; Bertola et al., 2018
			Lessini Plateau	25-50		
			Umbria-Marches Apennines	250-270		
Ovčja jama	G	Notranjska region	--	--	--	--
Büs dei Lader	ND	Lombard Prealps	Baldo/Lessini Plateau	25-50	25-50	This study
Paina, layer 6	EE	Venetian Prealps	Berici Hills	5-15	5-270	Broglia et al., 2009; Bertola et al. 2018
			Lessini Plateau	25-50		
			Umbria-Marche Apennine	250-270		
Trene	EE	Venetian Prealps	Berici Hills	5-15	5-270	Broglia et al., 2009; Bertola et al. 2018
			Lessini Plateau	25-50		
			Umbria-Marches Apennines	250-270		
Buso Doppio Broion	EE	Venetian Prealps	Berici Hills	5-15	5-270	Romandini et al. 2015; Bertola et al. 2018
			Lessini Plateau	25-50		
			Umbria-Marche Apennine	250-270		
Col de La Stria	EE	Venetian Prealps	--	--	--	--
Šandalja II, layer C/d	EE	Istria	Istria	5-15	5-200	This study
			Friulan plain	25-50		
			Umbria-Marche Apennine	150-200		
Madonna dell'Ospedale	EE	Marche Apennine	Umbria-Marche Apennine	0-15	0-15	Cancellieri et al., 2015
Vlakno	EE	Dugi otok Island	Northern Dalmatia	20	20-350	Perhoč, 2020
			Umbria-Marche Apennine	180		
			Veneto Prealps	350		
Romualdova pećina	EE	Istria	Umbria-Marche Apennine	200	200	This study

Tagliente	LE	Venetian Prealps	Lessini Plateau	0-15	0-270	Bertola et al. 2018
Ljubičeva pećina	LE	Istria	--	--	--	--
Zala	LE	W. mountain Croatia	Kupa River	30	30-300	Vukosavljević et al., 2015; Perhoč, 2020
			Lika region	75		
			Istria	100		
			Northern Dalmatia	115		
			Lessini Plateau	300		
Baracche	LE	Marche Apennine	Umbria-Marche Apennine	0-15	0-15	Peresani et al., 2005
Campo d. Piane CPD7	LE	Abruzzi Apennine	Apennine foot	5-25	5-25	Olive et al., 2017

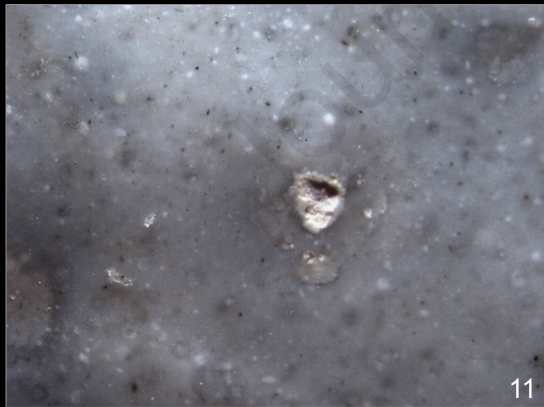
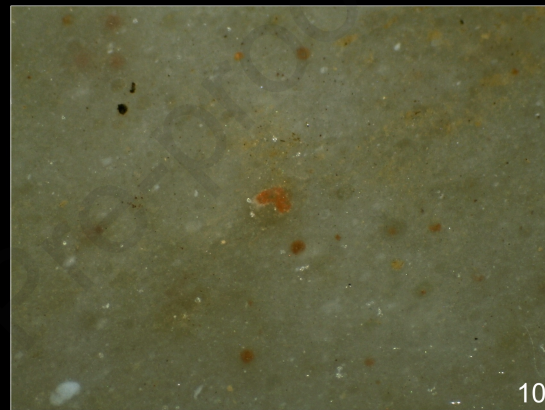
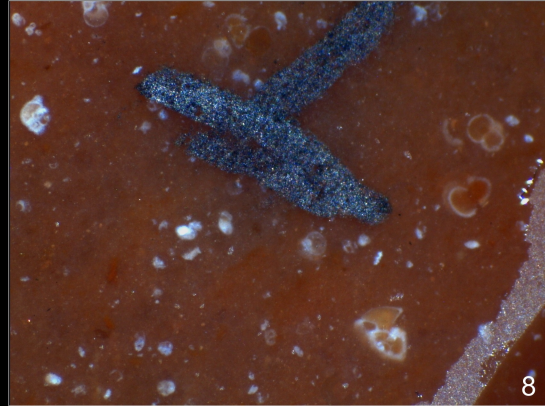
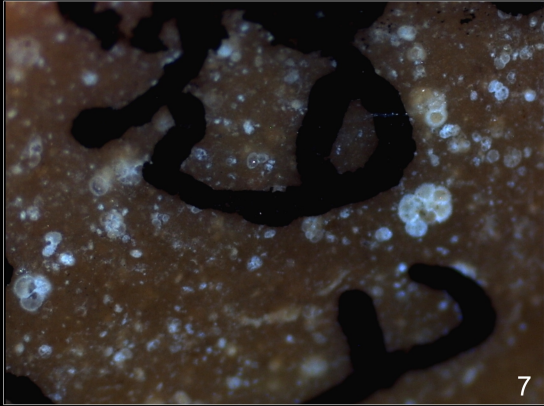
Vegetation ecozones	Main ecoregions	Potential vegetation formations, characteristic plant taxa, and main predicting pollen and macrofossils types (marked with an * and a §, respectively)	Fossil sites in the ecozones
Alpine vegetation ecozones (unglaciated areas beyond the Alpine timberlines)	bare ice and debris covered glaciers	Cushion vegetation on fresh moraine ridges Other petrophytic vegetation Cryonival algal and microbial communities	No ancient ice preserved
	other areas under active geomorphic processes	Alpine rockfields and steeplands	Cerete ¹ , Piovesello ²
	nival to sunny slopes (including nunataks)	Petrophytic deserts with <i>Plantago alpina</i> type*, <i>Armeria</i> *, Dipsacaceae* Rocky steppe Steppe-grasslands with <i>Carex humilis</i> , <i>Stipa</i> spp. and xerophilous chamaephytes (<i>Helianthemum</i> *, <i>Artemisia</i> *, <i>Juniperus</i> *, etc.) Alpine grasslands with <i>Festuca</i> spp. <i>Carex</i> spp., <i>Sesleria varia</i>	
	cold waterscapes	e.g. Cold spring herb communities, cold limnic ecosystems	
Alpine timberline			
Mountain-piedmont ecozones under a moist climate	stable or stabilized fields, no edaphic drought, especially on gentle slopes	Forests and woodlands. <i>Pinus mugo</i> dwarf forests at the alpine timberline mainly in the Eastern Calcareous Alps; open boreal forests; larch-scots pine woodlands at the continental timberline.	L. Alserio ³ , L. Annone ⁴ , Azzano Decimo ⁵ , Broion Cave ⁶ , L. della Costa ⁷ , L. Fimon ⁸ , L. Ganna ⁹ , L. Origlio ¹⁰ , Paina Cave ¹¹ , Paul di Manerba ¹² , L. Piccolo di Avigliana ¹³ , Renče ¹⁴ , Revine ¹⁵ , Trana ¹⁶
	edaphic drought, especially on limestone plateau, ridges, and sunny slopes	Grasslands, steppes, rocky steppes, alpine rockfields and steeplands (see above)	
	cold waterscapes	Salix and tall-herbs riverside formations; cold limnic ecosystems	
	thermal springs (Euganei Hills)	Patches of thermophilous woody formations with <i>Corylus</i> , deciduous <i>Quercus</i> , <i>Tilia</i> , <i>Ulmus</i> , <i>Fagus</i> , etc (cryptoregium)	
Continental timberline			

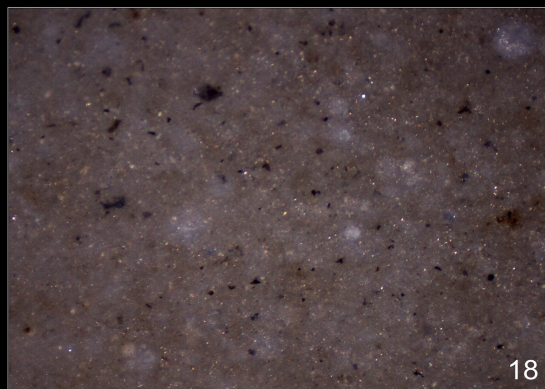
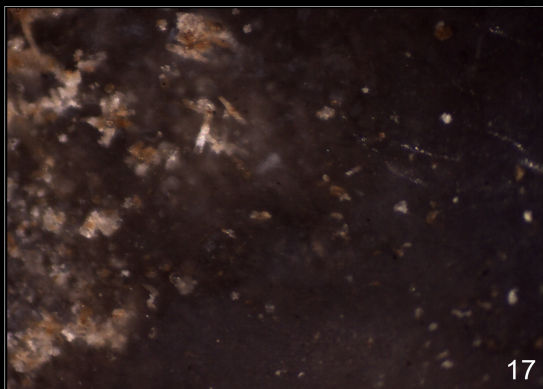
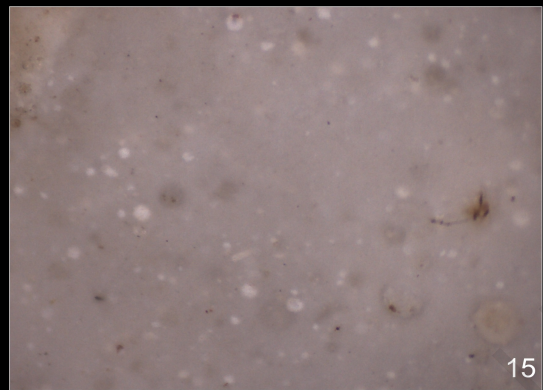
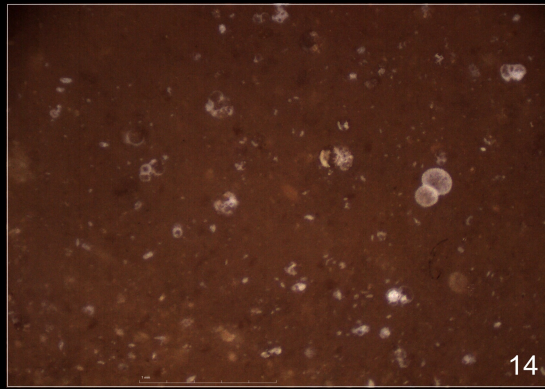
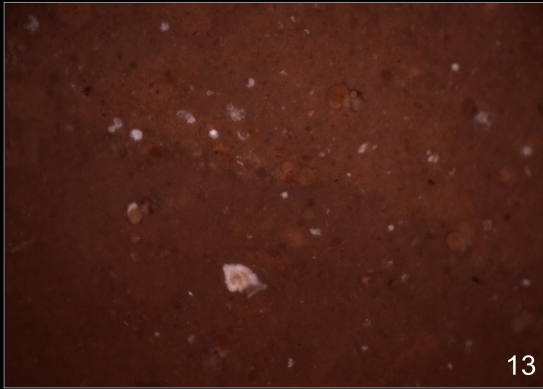
Mountain-piedmont ecozones under a semiarid climate	stable terraced piedmont areas with loess accumulation and isohumic soils development under grasslands	Steppes and semideserts with Gramineae, Compositae, <i>Hippophæe*</i> , <i>Erica</i> , <i>Berberis?</i> , <i>Rhamnus*</i> Tree grooves (<i>Betula</i> , <i>Pinus</i>)	Azzano Decimo ⁵ , Cà Fornera ¹⁷ , Casaletto Ceredano ¹⁸ , Galzignano ¹⁹ , Ghedi ²⁰ , San Donà di Piave ²¹ , Venice Lagoon ²² , L. Vrana ²³ , Valun Bay ²⁴
Plain ecozones (mostly depending on edaphic moisture)	active megafans - bars, dunes and abandoned riverbeds on coarse-grained sediments	Edaphic semideserts with xerophytic herbs and shrubs (<i>Artemisia*</i> , <i>Chenopodiaceae*</i> , <i>Hippophae*</i> , <i>Juniperus*</i> , <i>Ephedraceae*</i> , etc.)	
	stable surfaces - dune and loess fields under semiarid climate	Climatic semideserts and deserts with <i>Artemisia</i> and Gramineae (poorly documented by fossil sites)	
	active river channels in lower megafan belts	Riverside vegetations with tree <i>Betula*</i> and <i>Alnus incana</i> patches, and tall herbs (Umbelliferae). In drier spots, riverbed lithophyte communities with <i>Juniperus*</i> heaths and <i>Pinus sylvestris*</i> parkland, with Fabaceae, <i>Erica</i> , <i>Ephedra*</i> .	
	fine-grained sediments under water-saturated conditions	Wetlands (<i>Carex</i> spp., <i>Eriophorum</i> spp., mosses, e.g. <i>Scorpidium</i> [§]), birch (<i>B. pubescens</i> [§]), poplar and alder swamps	

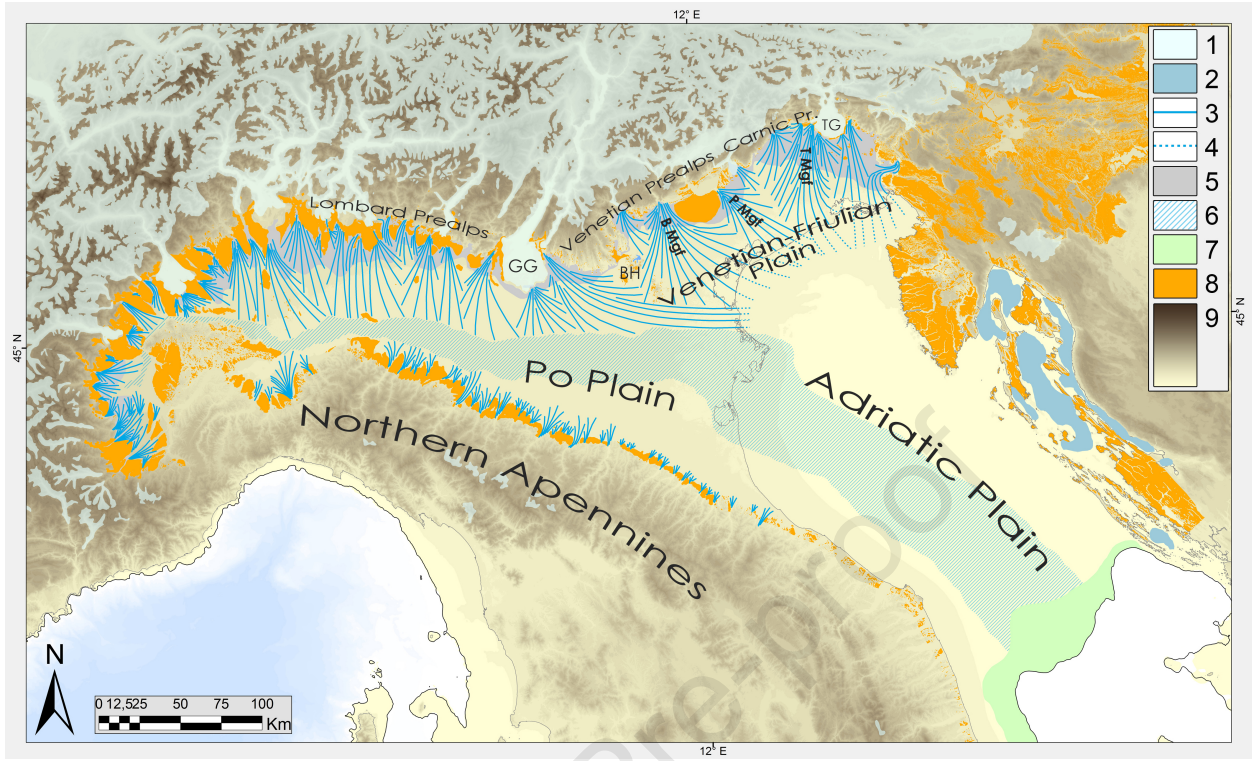
Tab. 1 - A frame of predicted ecological zones and summary of potential vegetation formations in the Great Adriatic - Po Region (GAPR) during the LGM and early Lateglacial (30 - 16 ka cal BP). The ecosystem classification here adopted relies on the recognition that ecosystem properties are closely tied to both physical and biotic site factors (see e.g. McLaughan et al., 2010; in mountain areas: xxx). The application of this approach to past environments embraces both the identification of predicting abiotic factors, provided by Quaternary geology (see sections xxx in this paper) and the biodiversity provided by a number of fossil palaeoecological sites. * - taxa documented by the pollen record; § - taxa documented by the macrofossil record.

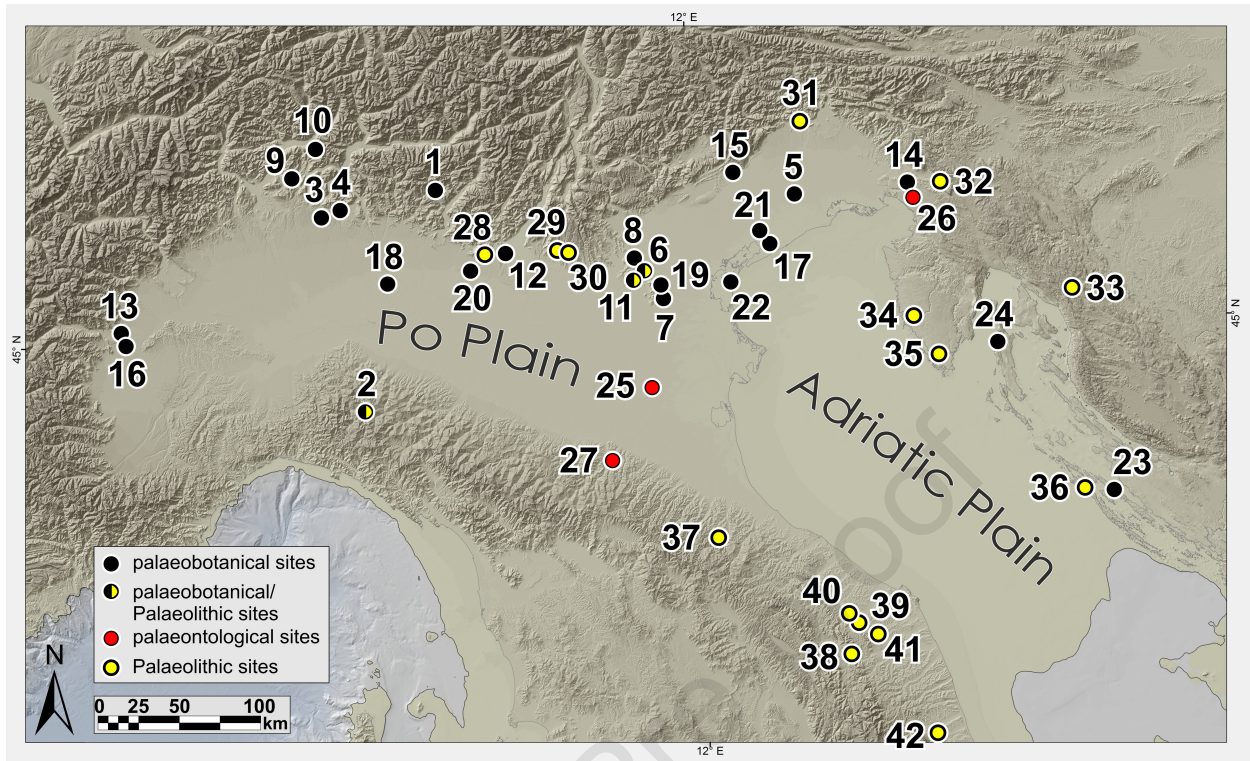
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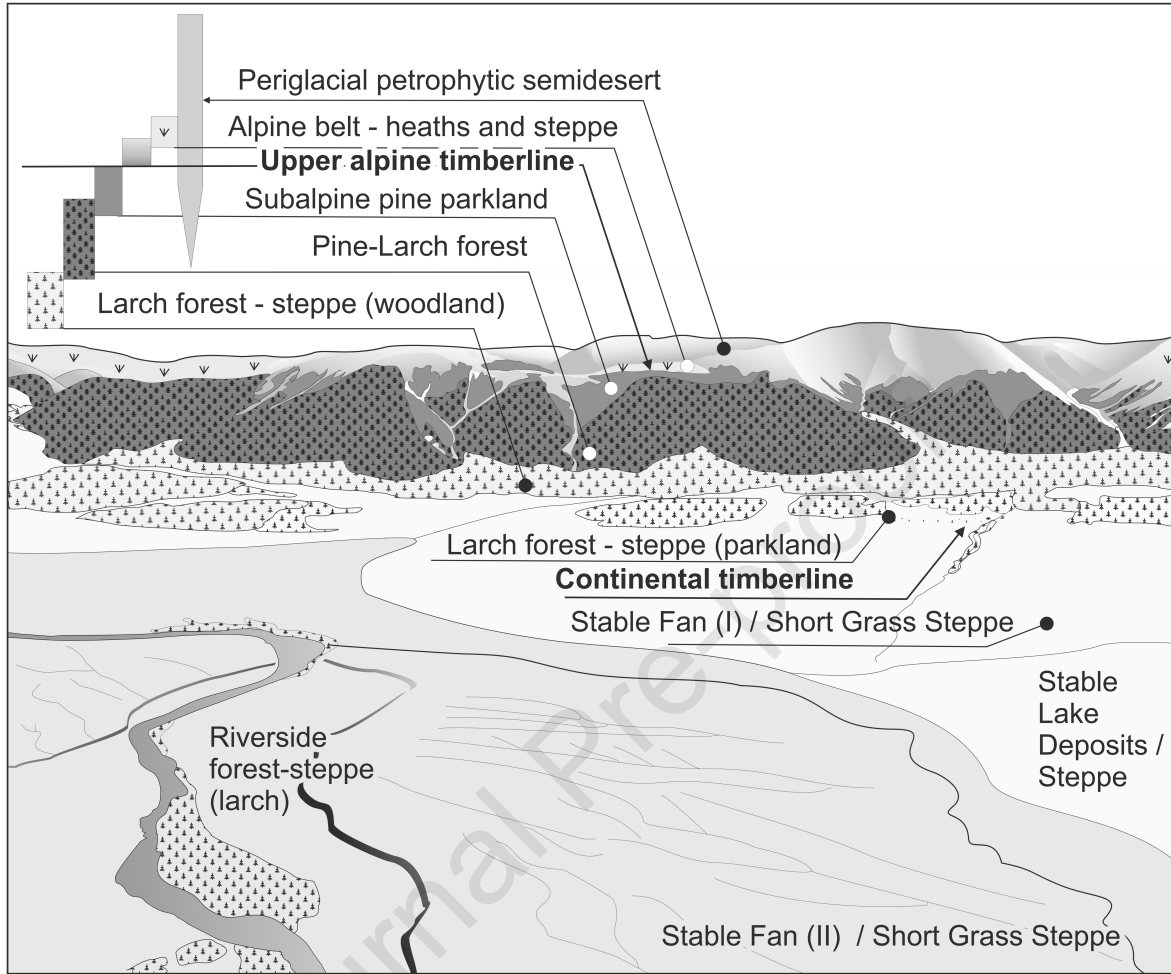


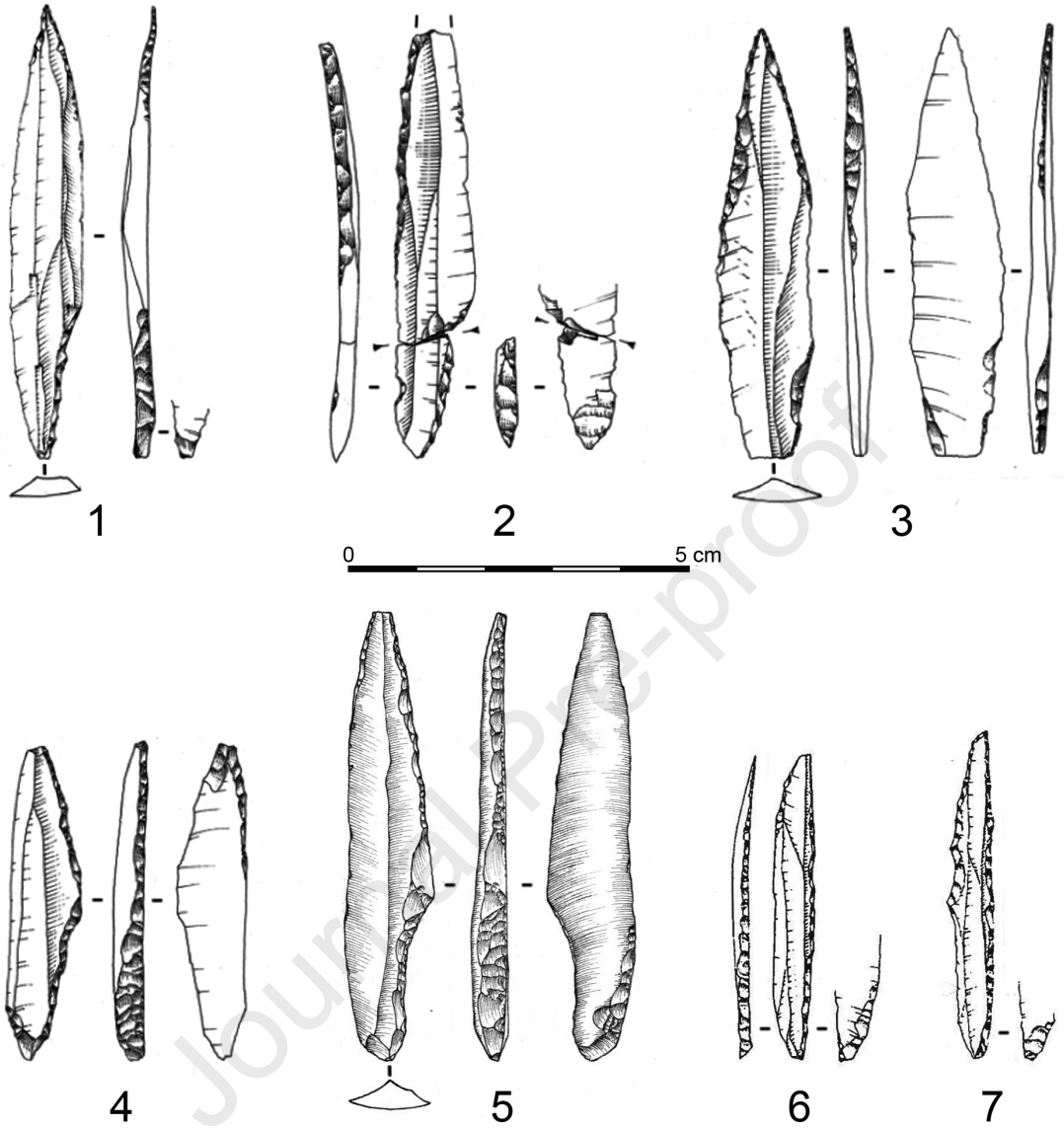


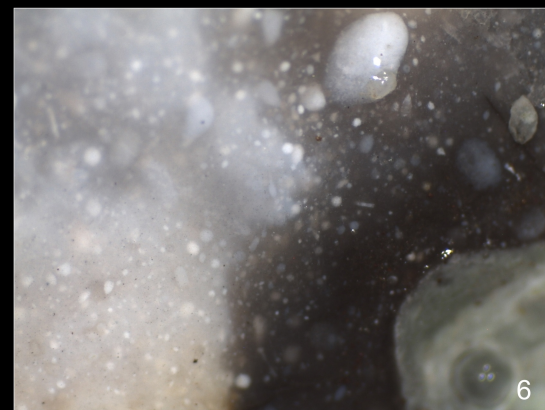
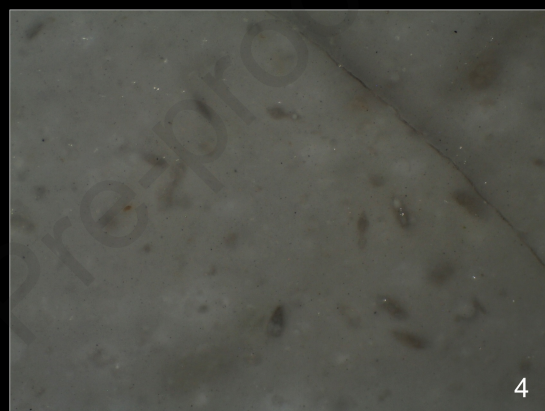
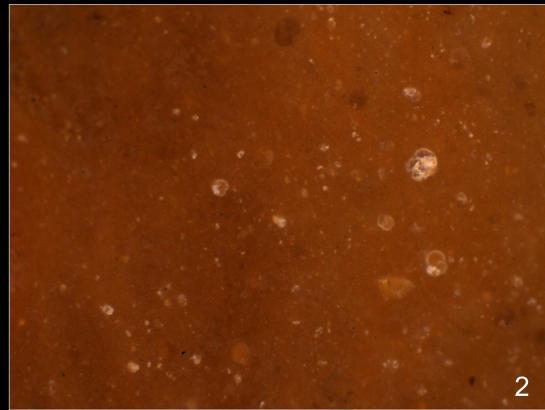
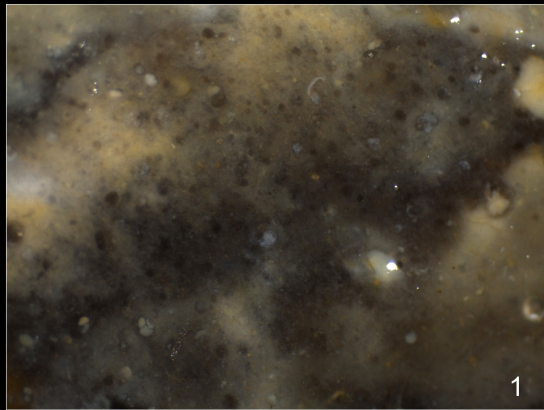


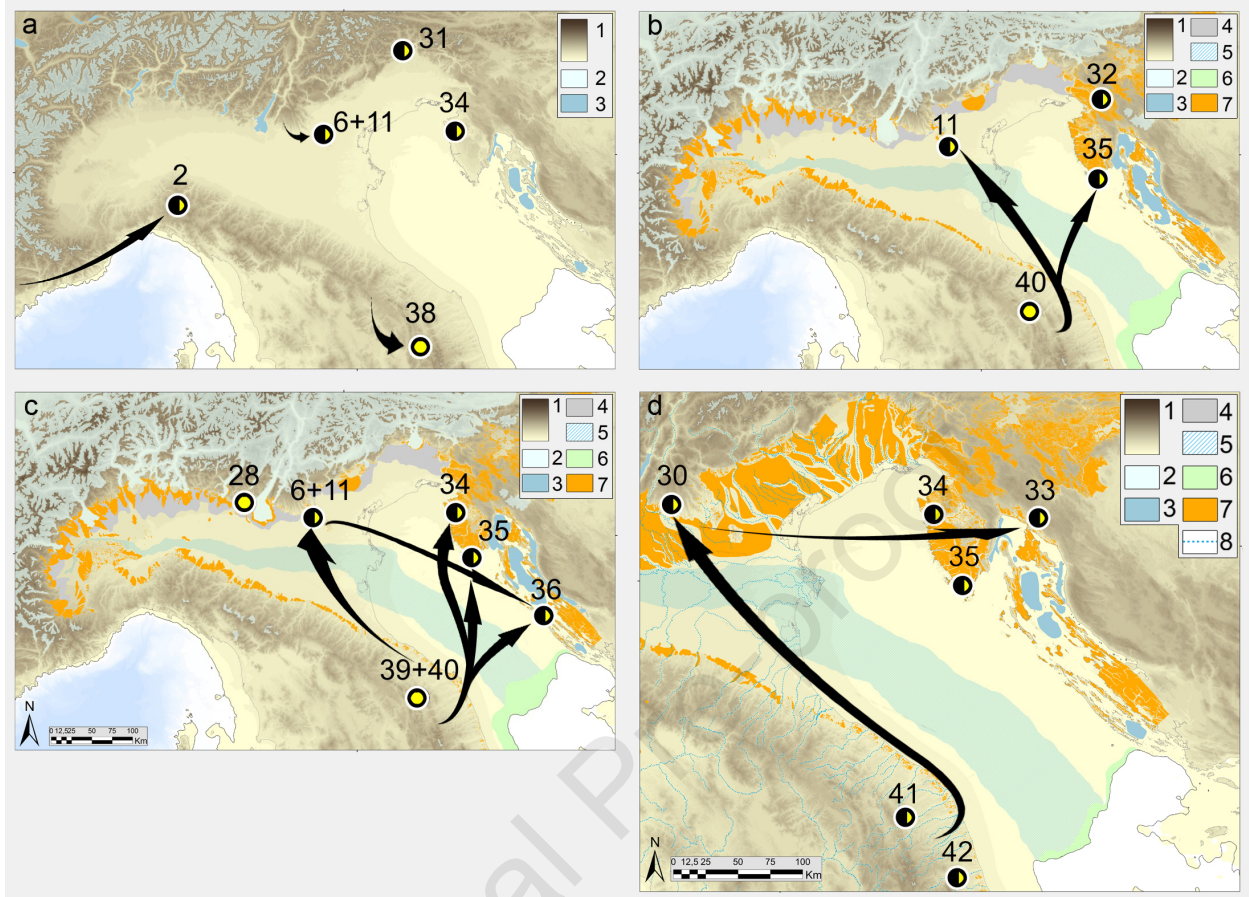












Declaration of interests

The authors declare that they have no known competing financial interests or personal relationships that could have appeared to influence the work reported in this paper.

The authors declare the following financial interests/personal relationships which may be considered as potential competing interests:

A handwritten signature in black ink, appearing to read 'Rosa Jones', is written over the signature line.

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