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1 Enlightening the darkness: The potential of charcoal analysis for the study of vegetation
2 dynamics and relative exploitation at Krania during the Iron Age Greece

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15
16 Abstract:

17
18 In the framework of the NWO project “What went into the melting pot? Land-use,
19 agriculture, and craft production as indicators for the contributions of Greek migrants and
20 local inhabitants to the so-called Greek colonization in Italy (ca. 850-550 BC)”, science-
21 based methods are employed to analyze and compare the organization of subsistence
22 strategies in the Greek motherland and in the indigenous and colonial milieus of Italy
23 (Crielaard et al. 2020). As a part of the subproject ‘Flora & Fauna’, which focuses on
24 farming practices, subsistence strategies and surplus production, Iron Age material from
25 the settlement of Krania in the Pieria region of Greece was analyzed. The site was
26 excavated in 2001 and revealed occupation phases from the 3rd millennium BC to the
27 Hellenistic period. The amount of ceramics recovered demonstrates the importance of
28 trade with the rest of Greece, in particular Corinth, providing evidence for long-standing
29 contacts and networks. Two pit structures contained a high concentration of material,
30 notably charcoal and ceramics dating to the 9th-8th centuries BC. This material constitutes
31 an interesting case study in itself but also as a regional *comparandum* with other Greek
32 assemblages. This paper discusses how anthracological analysis can contribute to our
33 understanding of human-environment interactions, anthropogenic practices and
34 environmental management.

35
36 Keywords: Anthracology; Greek colonization; Iron Age; Ancient Greece; Macedonia;
37 Krania

38 39 1. Introduction and background

40
41 During the transition from the Bronze Age to the Iron Age, a decrease in regional contact
42 is noticeable in Greece. Archaeological evidences such as craft production, pottery and
43 jewellery attest some contact between the South and the North regions (Gimatidis et al.
44 2018, Gimatidis 2020). However, during the 9th century BC, signs in the recovery of
45 regional exchange are noticeable, suggesting an increase of contact between the Southern
46 Aegean, Italy and the Northern Aegean (Broodbank 2013). In this new dynamic period,

47 migrants from the Aegean started to settle along the shores of the entire Mediterranean
48 basin. Among the reasons for this migration were the favourable opportunities for
49 economic and social expansion, permitted by territories that were not prior occupied by
50 Greek communities. The necessity to adapt to new lands and develop relevant practices,
51 raises the question of the migrants' ability to manage within new environments and carry
52 out different agricultural practices. However, agriculture and exploitation of natural
53 resources have not been included in the present debate about the so-called Greek
54 colonization movement, despite the fact that studying its organization during the initial
55 phase of the Greek migrations to Southern Italy is an important aspect when approaching
56 these ancient communities (Renfrew 1972, Foxhall 1995, 2015). Over the last decades,
57 agricultural practices and subsistence economies were generally not considered to be a
58 decisive factor in understanding the social, political, and economic aspects of these
59 ancient communities.

60 Examining subsistence helps us to better understand the level and degree of interactions
61 between indigenous and allochthonous populations. It also permits to evaluate
62 chronological and spatial continuities or discontinuities in economic activities. Finally, it
63 allows us to detect Greek influences in autochthonous settlements and vice-versa as it
64 directly affects the primary and fundamental stages of the development of societies
65 (Crielaard and al. 2020). The confrontation of subsistence regimes and strategies over time
66 and space in Greece and Southern Italy is a complex approach that needs to be considered
67 stepwise. Three different geographical scales are defined in the frame of the
68 'Flora&Fauna' project: microscale (site level and case studies), macroscale (results from
69 the case studies in a broader spatial, diachronic and cultural contexts) and megascale
70 (confrontation of the macroscales observations).

71 Unfortunately, limited archaeobotanical evidence has hampered the understanding of the
72 socio-economic role of primary goods. Although the study of macroremains has helped to
73 counterbalance this lack of knowledge, anthracology can be applied, especially to
74 approach landscape reconstructions and their related land use. Although charcoal is
75 collected more frequently in excavations these days, anthracology applied to the 1st
76 millennium BC is still developing in Greece and the material is usually kept in storage and
77 seldomly studied (Lentjes 2015). Only four settlements have been analysed thus far for
78 Iron Age Greece: Delphi (Renault-Miskovsky and Thiébault 1997), Plakari (Lentjes
79 2015), Corinth (Bookidis et al. 1999), and Krania (in this connection, the island of Crete is
80 not considered due to its strong ecological and cultural differences with the rest of
81 Greece). A fair amount of palynological work in Greece has been applied to prehistoric
82 contexts but few of these are specifically aimed at reconstructing the direct environment of
83 ancient settlements (Lentjes 2015). While it is perilous to reconstruct the natural
84 environment of settlements based solely on charcoal datasets without including other
85 proxy data such as pollen, charcoal analyses can provide interesting insights for landscape
86 reconstructions and their related land use. Through charcoal analyses, it is possible to
87 obtain an idea of the local signal of the vegetation as well as to make an estimation of
88 species selection, woodcutting, and/or clearance practices (Chabal et al. 1999, Asouti and
89 Austin 2005, Chabal and Kabukcu 2021). This paper focuses on the local environment of
90 the Krania settlement. Krania's charcoal represent a part of the microscale approach
91 within the "Flora&Fauna" project. This original study, by allowing us to examine the use
92 of wood resources in the local environment of the settlement, constitutes an important

93 case study, independent on its own, but also significant to enrich macro- and megascales
94 corpus. Combining charcoal assemblages with the pollen record allows us to determine
95 various aspects of the ecological milieu (open areas, potential fruit growing strategies,
96 landscape reconstructions, land use and resource accessibility, Lentjes 2015). Through
97 this, we can create a more complete picture of the exploitation strategies in Iron Age
98 Greece.

99

100 2.The Site of Krania

101

102 2.1. Location and environmental setting of the area

103

104 The environmental background of the studied area significantly determines the taxa
105 distribution and availability, influencing the potential character of woodland management
106 and cultivation practices (Shackleton and Prins 1992, Delhon 2021). This is true for today
107 as well as for the past.

108 The Pieria region, situated in the southern part of Macedonia (fig. 1), is surrounded by the
109 Aliakmon River to the north and the Peneios River delta in the south (Hammond 1972,
110 123; Margaritis 2005, 66).

111 The plain of Kateríni, opening to the Aegean Sea on the east, is one of the largest and most
112 fertile areas of Greece and forms the center of Pieria. In the area along the Thermaic Gulf,
113 a narrow coastal strip separates the Pieria and the Olympus massif from the Aegean. The
114 site of Krania is located in the lowland of Pieria, in a fertile passage connecting
115 Macedonia with Thessaly. The inland part of Pieria is a terraced land, deeply cut by many
116 streams, with passes connecting the lowlands and the mountainous areas (Poulaki 2013,
117 21; Margaritis 2005, 67).

118 The temperatures in this region are generally lower than the typical Mediterranean climate
119 that easily goes beyond 35°C in summer (Polunin 1987; King et al. 1997). The mean
120 annual rainfall is between 500-750 mm (Semple 1932, 86; Anathasiadis 1975; Polunin
121 1987, 13; Margaritis 2005, 67).

122 The foothills of Mount Olympus, where Pieria is located, are composed of marls, schists,
123 volcanic lavas, and other rocks (Polunin 1987, 2; Margaritis 2005, 67; Gerasimidis et al.
124 2008). The main types of vegetation in the Balkan Peninsula are divided according to
125 altitude zones: lowlands and hills (app. 0-700m), montane forests (app.700-1700 m), sub-
126 alpine and alpine (app. 1700-3000m). The studied site lies within the lowland zone where
127 Mediterranean plant communities are dominant, characterized by the prevalence of
128 evergreen trees, shrubs and small aromatic shrubs (Strid 1980, Polunin 1987). Various
129 halophyte and psammophyte species can be found near the sea and stands of *Platanus*
130 *orientalis*, *Salix* sp. and *Populus alba* characterized the foreshores. *Quercus coccifera*, *Q.*
131 *ilex*, *Q. pubescens*, *Q. trojana*, *Cistus*, *Juniperus oxycedrus*, *Laurus*, *Cercis siliquastrum*,
132 *Acer campestre*, *A. monspessulanum*, *A. sempervirens*, *Rhamnus alaternus*, *Carpinus*
133 *orientalis*, *Fraxinus angustifolia*, *F. ornus*, *Cornus*, *Pistacia*, *Arbutus unedo*, *A.*
134 *andrachne*, etc. are representative of macchie environment, characterized with hard leaf
135 evergreen shrubs in near-coastal areas. Phrygana is also represented with *Quercus ilex*,
136 *Cistus*, *Rhamnus*, *Olea* and *Pistacia*. Transitional and central European plant communities
137 are found in association with Mediterranean sclerophyllous forests at an average altitude
138 of 200-300 m. *Quercion ilicis* can be associated with *Quercus ilex*, *Q. coccifera*, *Pinus*

139 *brutia*, *P. halepensis* (Anathasiadis 1975, Dimopoulos et al. 2013). Dense scrub forests
140 are composed of *Crataegus monogyna*, *Rosa canina* and *Vitex agnus-castus* (Anathasiadis
141 1975). *Olea europaea* var. *oleaster*, *Fraxinus oxycarpa* and *Alnus glutinosa* are notably
142 found around the swampy areas near Litochoro (Anathasiadis 1975). At higher altitude, up
143 to 400 to 700 m. a.s.l., mixed deciduous forests with notably ostryo-carpinion associations
144 are represented. Throughout river valleys and flood plains from the coastal hills evergreen
145 woods are replaced by *Platanus orientalis*, *Alnus glutinosa*, *Populus alba*, *P. nigra*, *Salix*
146 *alba*, *S. amplexicaulis*, *S. eleagnos*, *S. fragilis*, *S. rubens*, *S. triandra*, *Rhamnus alaternus*
147 etc. At higher altitude, other associations are present, such as Buxetum sempervirentis
148 involving *Quercus coccifera*, *Q. pubescens*, *Q. conferta*, *Carpinus orientalis*, *Pistacia*
149 *terebinthus*, *Cotinus coggygria*, *Fraxinus ornus*, *Colutea arborescens*, *Acer*
150 *monspessulanum*, *Ostrya carpinifolia*, *Salvia argentea*, *Campanula sprunerana*,
151 *Parietaria officinalis*, etc. Forming the high mountain vegetation, Quercetalia pubescentis
152 and Quercion conferta are present, with *Q. pubescens*, *Q. conferta*, *Q. petraea*, *Acer*
153 *campestre*, *A. hyrcanum*, *Juniperus oxycedrus*, *Corylus avellana*, *Sorbus torminalis*,
154 *Ostrya carpinifolia*, *Carpinus betulus*, *Rhamnus fallax*, that form notably small bushes.
155 Other associations, such as Fagetalia forests, Pinion heldreichii, Abieton cephalonicae,
156 Fagion moesiaca are distributed in the surrounding of Mount Olympus (Anathasiadis
157 1975). The present-day vegetation in the vicinity of the settlement has been highly
158 influenced by anthropogenic activities, causing rapid changes in vegetation structure and
159 composition. The anthracological remains can be perceived as remnants of the ancient
160 vegetation, from both regional and local hotspots that still comprise a high tree richness
161 (including 146 native including endemics, Quézel and Médail 2003, Médail 2008, Médail
162 et al. 2019).

163

164

165 2.2. Archaeological background of Krania – ancient *Irakleon*

166

167 The settlement of Krania was excavated in 2001 under the direction of E. Poulaki-
168 Pandermali, under the auspices of the Euphorate of Antiquities of Pieria, as part of the
169 construction work for the new Athens-Thessaloniki railway. The site is situated at the
170 northern foothill of Platamon Hill, 200 meters from the sea and at 10 meters above sea
171 level (Margaritis 2007). Its particular location, on the lower Olympus, provides Krania
172 with a strategic position above the Tempi valley (Poulaki 2003). Krania was likely a part
173 of the harbor district of the ancient city of Irakleon (Poulaki 2001; Margaritis 2007).

174

175 Studies of the stratigraphy and archaeological finds revealed a discontinuous
176 occupation from the 3rd millennium BC to the 4th century AD, with several phases of
177 destruction. A Bronze Age monumental *peribolos* (stone enclosure) was destroyed by a
178 fire during the Early Iron Age. The settlement was destroyed again during the 8th century
179 BC and covered by a homogeneous layer of destruction. Habitation consisted of
180 orthogonal buildings, terraces, and *peribolos* walls, as well as apsidal buildings. Within
181 these, finds relating to the daily life were preserved such as domestic utensils, loom
182 weights, and vessels used for various purposes, in addition to animal bones and clams (fig.
2,3).

183 The archaeobotanical material, both seeds and charcoal, are dated to the 9th and 8th
184 centuries BC, i.e., towards the end of the site's Iron Age occupation. The samples come
185 from two structures that were part of the habitation area on the slope of the hill. The first
186 pit, Pit A (approx. 2 m x 1.5 m in size and one meter in depth), contained large amounts of
187 amphorae and other storage vessels that were in situ but broken. Charred plant remains
188 and charcoals were visible on these fragments. Pit B, which is larger than Pit A and
189 ellipsoid in shape, had off-white coating and contained vessels as well as two storage
190 amphorae next to a brazier, an iron axe, nails, and other types of vases (Poulaki 2001;
191 Margaritis 2007). The two pits do not seem to be connected to any building. The pottery
192 fragments are characteristic of Corinthian production and suggests contacts and potential
193 trade between the inhabitants of Krania and areas in the Southern Aegean. In addition to
194 these Corinthian imports, there is pottery that belongs to the Thessalo-Euboean *koine*
195 (Poulaki-Pantermali 2013).

196 The two pits have yielded one of the largest assemblages of plant macroremains in Early
197 Iron Age Greece with the presence of *Sesamum indicum* which suggests long distance
198 trades with the Eastern Mediterranean (Godefroy and Margaritis, in preparation).
199 Following up on E. Margaritis' preliminary analysis of 2007, for the present study almost
200 10 000 macroremains were analyzed (Godefroy and Margaritis, in preparation). Based on
201 field information and preliminary archaeobotanical analysis, it appears that the mode and
202 type of filling is different between the two pits. Pit A is interpreted as a burned
203 underground grain storage structure, while pit B could be a detrital pit composed of
204 various episodes of domestic refuse (Margaritis 2017, 684). Moreover, the assemblages
205 are unique since they provide solid evidence for the exploitation of the settlement's local
206 environment.

207
208

209 3. Material and method

210

211 The two studied pits were sampled for organic remains. The volume of soil collected for
212 pit B was between 12-18 liters. In Pit A, the deposit consisted of large quantities of
213 charred plant remains, visible during the excavation, for a minimum of 86 liters
214 (Margaritis 2017, 124). Each pit has been sampled using the same method: the filling has
215 been subsampled and documented according to the type of material and deposition units.
216 The sediment samples from the site were processed by E. Margaritis with the help of a
217 flotation machine. The sieves used during flotation were of two mesh sizes: 1 mm for the
218 coarse flot and 300 μ for the fine flot. The riddle retaining the 'heavy residue' of the
219 samples was of 1mm mesh size.

220 In the laboratory, charcoal were separated from the rest of the organic fraction using a 4
221 mm sieve which enabled isolation of the biggest fractions from the rest. The pieces bigger
222 than 4 mm were then identified under an Olympus BX51M microscope with a
223 magnification of 50x-500x. For the identification, anatomic criteria were used and
224 compared with atlas (Jacquiot 1955, Schweingruber 1990, fig. 4) and the charcoal
225 reference collection of the AASPE laboratory at the National Museum of Natural History
226 in Paris. The wood charcoal recovered at Krania were well preserved, although there was a
227 high rate of fragmentation. The charcoal fragments were individually counted.

228

229 4. Results

230

231 4.1. General remarks

232

233 A total of 269 fragments were analyzed to obtain a representative picture of Krania's past
234 environment. The archaeological study of the pits is not complete and therefore, not all
235 charcoal samples could be linked to the stratigraphical data. Of 123 samples, 83 were
236 further analyzed because of their correspondence with stratigraphic descriptions.

237 However, of these 83 samples, only 12 samples with charcoal remains could be linked to
238 either Pit A or Pit B.

239

240 4.2. Pit A

241 A total of 11 charcoal samples and 197 fragments were analyzed, which constituted the
242 biggest dataset of the two structures. Fourteen taxa were identified. The pit assemblage is
243 dominated by oak (*Quercus* spp., 25%), including deciduous and evergreen types, as well
244 as pine (*Pinus* spp., 24 %, tab. 1). *Pinus* cf. *sylvestris/nigra* has been identified based on
245 fenestriform pits and dentate tracheid walls present in the cross-fields. In addition, *P.* cf.
246 *peuce* was discriminated based on the small areolate punctuation on the tracheid walls in
247 the final wood, on the presence of two pits per cross-fields but also on its prevalence in
248 Macedonia since no anatomic distinction can be observed between *P. cembra*, *P. peuce*
249 and *P. strobus* (Jacquiot 1955, Shwreingruber 1990). Both taxa (*Quercus* spp., and *Pinus*
250 spp.) are present in most of the samples collected from this pit. The secondary taxa are
251 olive (*Olea europaea*), ash (*Fraxinus*), maple (*Acer*), and *Cornus/Cornus mas* (between 5
252 and 15% each). Cornelian cherry (*Cornus mas*) was identified thanks to its characteristic
253 anatomical criteria, such as less distinct growth ring boundaries, fewer pores, and thicker-
254 walled fibre tracheids in comparison to common dogwood (*Cornus sanguinea*). Regarding
255 *Cornus*, the remains are from one sole sample, suggesting an overrepresentation of the
256 fragments for this taxa in this pit. The distribution of other secondary taxa is overall
257 homogeneous in this structure, found together with a concentration of pottery. Finally,
258 plane (*Platanus*), *Phillyrea*/buckthorn (*Phillyreal/Rhamnus*), common hornbeam
259 (*Carpinus*), *Cercis*, strawberry tree (*Arbutus unedo*) and alder (*Alnus*) constitute between
260 4 and 0,5 % of the assemblage.

261

262 4.3. Pit B

263

264 During the analyses of bag NK280, which was the single documented sample with
265 charcoal for this structure, 72 pieces of charcoal were studied. Thirteen taxa have been
266 identified; the assemblage is dominated by maple (24%), oak (23%) and pine (14%, tab.1).
267 The secondary taxa identified are *Cornus/Cornus mas* as well as olive and ash (between 5
268 and 9% each). Besides, strawberry tree (*Arbutus unedo*), elm (*Ulmus*),
269 *Phillyrea*/buckthorn (*Phillyreal/Rhamnus*), *Cercis* and Maloideae were identified each
270 between 4 and 1% of the assemblage.

271

272 4.4. Comparison of the two pits

273

274 The comparison of the anthracological assemblages of the two pits must be made with
275 caution. The number of samples and relative wood pieces are higher in Pit A than in Pit B
276 which accompany the highest range of species diversity. In fact, Pit B, is represented by a
277 single sample with a restraint taxa diversity that brings an over representation of some
278 taxa in the assemblage. For example, in Pit A, *Quercus* spp. together with *Pinus* spp.
279 dominate whereas *Acer* together with *Cornus* are secondary. For pit B, *Acer* dominates
280 with *Quercus* spp. but *Pinus* spp. is secondary (see relative frequencies in tab. 1). In any
281 case, the similarities between both pits in terms of main taxa and equivalent taxonomical
282 diversity suggest the same filling profile. Furthermore, both pits belong to the same period
283 of Krania's settlement (between 9th and 8th centuries BC). However, the archaeological
284 context might be distinct, the charcoal from the fillings of these two pits may therefore
285 have different origins, i.e. construction wood or fuel for Pit A, or exclusively wood from
286 several domestic fires for Pit B. The species diversity in the pit B (n=13) is as diverse as in
287 the pit A (n=14) that does not support a possible selection for timber in Pit A. Pit A could
288 have been subject to an accidental fire or sanitation and used in a second time as a detrital
289 accumulation for example. As the charcoal are dispersed within both structures, they can
290 correspond to hearth emptying (direct or indirect) and not necessarily correspond to the
291 inner deposit layer of the pits. In both cases, no strict variability is observable from a
292 structure to another, both pits have coherent assemblages, which supports the idea of the
293 same exploited forest formation. Thus, the charcoal assemblage of Pit A and pit B can be
294 put together to discuss about the firewood exploitation at Krania during the Iron Age.

295

296 5. Discussion

297

298 5.1. Environment and evidence for woodland management practices around Krania for the 299 Iron Age period

300

301 The charcoal assemblage from Krania consists of 14 different wood taxa from specific
302 forest types (mixed deciduous forest, woodlands and shrubs, grasslands, xeric shrublands
303 etc.), allowing us to examine the use of trees and shrubs in and around the ancient
304 settlement.

305

306 5.1.1. Ecology, habitat and distribution

307

308 The assemblage contains three main taxa, including pines (*Pinus* spp.), oaks (*Quercus*
309 spp.), and maple (*Acer* sp.). The first two genus could be found in the vicinity of the
310 settlement, located in the lowlands. At Krania, both deciduous and evergreen oaks are
311 represented and can grow in the same milieu on different soil types and with different
312 slope inclinations. In Greece, they prefer shallow to moderate deep calcareous soils. Nine
313 oak species can occupy the region of Macedonia (*Q. cerris*, *Q. frainetto*, *Q. itharburensis*,
314 *Q. petraea*, *Q. pubescens*, *Q. robur*, *Q. trojana*, *Q. ilex*, and *Q. coccifera*; Dimopoulos et
315 al. 2013). Deciduous taxa prefer low to higher altitudes forests but some oak types can
316 also grow in shrubby macchie (*Q. coccifera*, *Q. pubescens*, *Q. trojana*) or as individual
317 trees in fields (*Q. pubescens*; Dimopoulos et al. 2013, Strid 1980). Evergreen oak is
318 mostly present as an undergrowth of coniferous woodland in the foothills of Mount
319 Olympus as well as evergreen shrubs in macchie, occasionally forming pure stands.

320 Considering the local environment of Krania, it is not surprising to have both types
321 represented in almost the same proportions. The presence of pine tree within the
322 assemblage fits with the dry and warm environment of the settlement. *Pinus nigra*
323 characterized the most dominant forest at Mt Olympus (between ca. 500 to 1500m.a.s.l.),
324 sometimes found in association with *A. campestre*, as well as it can be found in woodlands
325 and shrubs, often forming pure stands especially on dry ridges and slopes (Polunin 1987,
326 Dimopoulos et al. 2013). At low altitudes, a gradual transition from macchie to *P. nigra*
327 woodland is observable (Strid 1980, Dimopoulos et al. 2013). *Pinus sylvestris* presents the
328 same habitat's characteristics but can also form pure or mixed stands with *Fagus*
329 *sylvatica*, *Picea abies* and *Betula pendula* (Dimopoulos et al. 2013). Concerning maple,
330 the genus is associated to species that develop at higher altitudes such as Field maple (*A.*
331 *campestre*) and Montpellier maple (*A. monspessulanum*), which on average grow from a
332 minimum of 200 m.a.s.l. Other species such as Greek maple (*A. heldreichii*) can even
333 grow from 900m. a.s.l. (Strid 1980, Banaszczak 2010, Dimopoulos et al. 2013). Regarding
334 their current ecological distribution, *Pinus* and *Acer* may occur at a higher altitude than the
335 settlement of Krania.

336 As secondary taxa, cornelian cherry, is well represented in the assemblage. However, its
337 distribution is heterogeneous and has a higher concentration in Pit A, especially in the
338 sample NK185. It generally grows in altitudes between 200 to 1000 m. on slopes and
339 forest edges, in mixed deciduous forests with oak and hornbeam (Strid 1980, Dimopoulos
340 et al. 2013, Scheppelmann 2017).

341 The other taxa that represent a minority within the corpus follow the same tendencies in
342 terms of altitude, with an average ecological distribution around 200-300 m.a.s.l.
343 However, some taxa correspond to species that are also present in lower altitude
344 environments. *Cercis* sp., *Arbutus unedo*, *Platanus orientalis*, *Rhamnus saxatilis* or *Ulmus*
345 *minor* usually grow in coastal plain environments.

346
347 Krania's location and environs is characterized via the anthracological material by mostly
348 low and mid-high altitude species. The anthracological data coincide with species that can
349 grow at altitudes that correspond to the near environment of the settlement, mostly below
350 600m. a.s.l. The principal plant community is characterized by woodland and shrub type
351 (average altitude from 400 up to 1500 m. with lowest at 200m and highest up to 2200m),
352 as maple (*Acer* spp.), hornbeam (*Carpinus* spp.), *Cornus* spp., ashes (*Fraxinus* spp.), pine
353 trees (*Pinus* spp.), oriental plane (*Platanus orientalis*), poplars (*Populus* spp.), *Salix* spp.,
354 oaks (*Quercus* spp.). *Olea europaea* can also be found in this habitat, especially in dry
355 rocky slopes.

356 Mixed deciduous forest with oaks (*Quercus* spp.), oriental hornbeam (*Carpinus*
357 *orientalis*), ashes (*Fraxinus* spp.), and elms (*Ulmus* spp.) characterized the second main
358 habitat with minimum altitude of 100m. up to 2200 m. for certain species (Strid 1980,
359 Dimopoulos et al. 2013, Scheppelmann 2017). While they can be part of different
360 syntaxonomy (see 2.1), these vegetation units are also favourable for pine trees and elms,
361 forming a sub-association to oak (Pantera et al. 2009). On the other hand, the
362 representation of some plant communities, such as macchie or phrygana, by typical wood
363 taxa present in the samples (notably *Acer campestre*, *Arbutus unedo*, *Olea europaea* and
364 *Rhamnus lycioides*) are specific to a minimum altitude of 200 m.a.s.l.

365

366 5.1.2. Resource accessibility and woodland management

367

368 The diversity of wood taxa within Krania assemblage demonstrates a firewood
369 procurement area probably around the settlement as most of the taxa can grow below 600
370 m. a.s.l. However, the topography is particularly contrasted in the vicinity of the site. This
371 supports potential difficulties to access to the wooden resources, highlighting the
372 capabilities of the Krania community to adapt to their environment regardless of
373 constraints in accessibility, since the ascending elevation is higher than the altitude of the
374 settlement itself (fig. 5). This suggests that firewood was preferably collected in low and
375 mid-altitude and wood-pasture landscapes. The variability of the species associated to the
376 two pits is a good environmental indicator that can be discussed in the frame of
377 opportunist wood collection, following a least-effort pattern (Shackleton and Prins 1992,
378 Asouti and Austin 2005). The palaeoecological representativeness of the frequency spectra
379 of taxa can be established based on several parameters such as a large number of woody
380 species of all types, reproducible observations across the synchronous strata and structures
381 of a given site and anthracological taxon frequency spectra with high ecological
382 consistency (Chabal 1997; Chabal and Heinz 2021). However, it is not excluded that a
383 part of the charcoal fragments corresponds to selected taxa, for timber or other craft
384 products, whose by-products could have been used, in a second phase, as firewood.

385

386 Woodland management practices that result in the formation of anthropogenic habitats
387 range from the protection of tree stands from browsing, clearance of herbaceous ground
388 flora via burning or grazing and the selective removal of shrubs, to silvicultural practices
389 (Asouti and Kabukcu 2014, Asouti and Kabucku 2021). While it is difficult to address
390 these issues based solely on the diversity of anthracological assemblages, additional
391 informations about farming activities and wood use can be achieved by pollen studies that
392 documents the potential regional vegetation, including wood and herbaceous taxa.
393 For the area of Pieria, local and precise information is sparse, apart from an important
394 profile deriving from the area of Variko Litochoro (Athanasiadis 1975). It is situated some
395 15 kilometers north of Krania, at an altitude of 148 m. a.s.l. The Late Bronze Age –
396 Geometric period (1600-900 BC) is characterized by an increase in identified *Pinus*, a
397 strong decrease in *Quercus* and the gradual decline of *Alnus* and Poaceae. The period from
398 900-200 BC is the most relevant to the present study, and shows a decrease in *Alnus* and
399 *Pinus* findings, while the presence of *Salix* is expanding, potentially as a consequence of
400 the Iron Age climate depression, that might have had an impact on floodplain vegetation at
401 Litochoro (Athanasiadis 1975). This observation accompanies a decrease in the presence
402 of *Vitis* and Poaceae, potentially caused by stronger inundation (Athanasiadis 1975). Later
403 on, there is an increase in the values of *Castanea*, *Juglans*, *Cerealia*, *Humulus-Cannabis*
404 and *Vitis*, indicating a possible change in the use of the landscape with more open areas, as
405 well as a consequence of the Iron Age climate depression (Athanasiadis 1975, 1986, 1987,
406 2000). Indeed, the presence of open vegetation profiles accompanies the vegetation
407 dynamic of the Katerini plain. During the Iron Age period, areas of open vegetation due to
408 deforestation and agriculture (Athanasiadis 1975, Margaritis 2007) might have had an
409 impact on the forest vegetation profile within Pieria's immediate surroundings.
410 Although palynology provides complementary insights on human/environment
411 interactions, anthracology gives direct evidence of the presence and spread of woodland

412 species, which often go undetected by pollen analysis. In our case, poor and/or irregular
413 pollen dispersers like riparian taxa such as Salicaceae, *Acer*, *Populus* or *Fraxinus* are often
414 undetected in palynology (Tal 2006) but can be present within charcoal assemblages. For
415 example, some species such as *Fraxinus* are representative of forest communities which
416 are on the interface between forest and grassland environments (Brust 2017), reinforcing
417 evidence of open areas that were potentially adjacent to water courses and running water.
418 Plane (*Platanus*) easily grows in this habitat, which corresponds to the local environment
419 of Krania that is from sea level to ca. 900 m. The previous observation supports the
420 presence of alder (*Alnus*) and hornbeam (*Carpinus*), which grow next to freshwater
421 habitats and wet grounds in woods, forming woodland and scrub. The association of
422 riparian vegetation, open areas vegetation (meadow, macchie) and woodland and shrub
423 suggest that the exploitation of wood conducted nearby the settlement location is
424 plausible.

425

426 But what was the average distance that these populations could range from the settlement
427 of Krania to exploit wooden resources? Although the taxa distribution is characteristic of
428 the local environment of the settlement, some species that are typical of plant formations
429 can provide evidence for this. The development of macchie in the region starts from 200
430 m.a.s.l. Considering this parameter, the nearest point to Krania that corresponds with this
431 height is at a distance of ca. 900m. from the settlement. In addition, while the identified
432 taxa can grow in altitudes from 0 m. onwards, the main forest communities (woodland and
433 scrub and mixed deciduous forests) develop at an average altitude of a minimum of 200
434 m.

435 Considering that the settlement evolved within a defined perimeter, it fosters the idea that
436 forest exploitation can be associated partially with degraded forest zones, that is to say
437 macchie, particularly in low altitudes. The process of deforestation at low altitudes is
438 supported by pollen records, but also by diatomea analyses for the Late Holocene within
439 the region (Lawson et al. 2005, Kotthoff et al. 2008, Zhang et al. 2014). A decline of
440 temperate forests in ca. 3,500 cal yr BP and the reduction of the coniferous forest in ca.
441 2,500 cal yr BP is noticeable (Wagner et al. 2009, Zhang et al. 2014). Thus, human impact
442 might have constituted an important factor to the nutrient erosion of the soil and its related
443 deforestation via the expansion of agriculture and irrigation (Zhang et al. 2014). Both
444 anthropic and natural erosion may have had an impact on species distribution within the
445 ecosystem.

446 The presence of rivers close to the settlement, however, might have contributed to the
447 sufficient irrigation of potential fields, which is supported by the increase of cultivated
448 taxa within the pollen record (Anathasiadis 1975) and the high concentration of grains
449 (Margaritis 2007).

450 In Krania, some of the secondary taxa include fruit trees such as *Cornus*, cornelian cherry
451 (*Cornus mas*), and olive (*Olea europaea*). At low altitudes, rocky environments with thin
452 soils on slopes present particularly favourable conditions for olive trees, benefiting their
453 cultivation. This species can adapt to Xeric Mediterranean phrygana and grasslands,
454 showing a perfect adaptability to Krania's environment. The presence of olive in the
455 assemblage is not surprising as evidence of oleiculture is attested for the Iron Age in
456 Northern Greece (Foxhall 2007, Pagnoux 2016, Valamoti et al. 2018, Pratt 2021), and in
457 the assemblage from Krania (Margaritis 2007). While Pieria is situated in the foothills of

458 Mount Olympus, we can hypothesize that the destruction of oak forests in deep soils by
459 converting them to agricultural fields or cultivated terraces in the nearby environment of
460 the settlement, might have offered to economic species such as the olive tree the
461 opportunity to be more intensively cultivated at an average altitude of up to 300 m. This
462 situation corresponds approximately to a distance of 1.5 kilometers from Krania.
463 Obviously we have to keep in mind that the actual soil profile is different from the ancient
464 one, and the actual distribution of the vegetation within the landscape was relatively
465 different. In addition, we have to mitigate the importance of olive within the assemblage.
466 The presence of olive stones in addition to the charcoal could give an indication of olive
467 cultivation but few *Olea* charcoal is present in the pits, which could correspond, as for the
468 rest of the corpus, to fuel strategy rather than pruning residues. Considering this
469 observation, wood of wild olive tree could have been collected using the same non-
470 selective strategy as was used for pines and oaks. This observation is reinforced by the
471 presence of the fruit remains from Krania. Macroremains of cornelian cherry,
472 pomegranate (*Punica granatum*) and grapevine (*Vitis vinifera*) are also identified at
473 Krania (Margaritis 2007, Godefroy and Margaritis in preparation) and could be the result
474 of gathering and tree cultivation. However, charcoal occurrence of these three species does
475 not have a homogeneous distribution either concentration in the charcoal assemblage of
476 the two pits. From that perspective, *Olea* might have been used as fuel. However, those
477 species belong to the fruit growing tradition of the Iron Age, particularly in open areas in
478 phrygana and grasslands (Pagnoux 2016, Foxhall 2015). This raises the question, how
479 were areas close to the site organized and utilized? Potential cleaning of woodlands and
480 forests supports the idea of open areas within close vicinity of the settlement. This is also
481 supported by the large amount of cereals, indicated from the macroremains (Margaritis
482 2007).

483

484 5.2. Comparison of charcoal analyses from Iron Age Greece

485

486 As mentioned before, the few analyses of charcoal available in Greece make it difficult to
487 draw comparisons for the Iron Age. The charcoal assemblages that are discussed here have
488 been retrieved from only three archaeological sites, namely Corinth and Plakari in
489 southern Euboea as well as Delphi in Phokis.

490 At Corinth, a single piece of charcoal belonging to a pine tree was identified (Bookidis et al.
491 1999). At Plakari, about 38 pieces of charcoal were identified from 3 ritual contexts;
492 the assemblage is divided between the genus *Quercus* spp., *Quercus* cf. *cerris* and
493 indeterminate taxa (Lentjes 2015). The concentration of oak may be connected to the ritual
494 context, because of the specific selection of wood. At Krania, oak is also dominant but
495 associated to an important taxonomical diversity, which reinforces the hypothesis of a
496 non-selective strategy, especially considering the detrital context of pit A. However, the
497 presence of deciduous oak at Plakari is interesting. Deciduous oak is linked to closed
498 canopy forests while the evergreen type is specific to open environments like macchie.
499 Finally, the anthracological assemblage from the 9th and 8th centuries BC which belongs to
500 the Chariot of the Rhodians at Delphi is so far the richest corpus for the period (Renault-
501 Miskovsky and Thiébault 1997). Indeed, 282 charcoal were studied for the 9th century BC
502 while 1614 were analyzed for the 8th century BC. For both periods a majority of *Quercus*
503 *ilex/coccifera* is noticeable which may be due, as for Plakari, to the ritual profile of the

504 context. A significant amount of coniferous wood, including *Abies* sp., cf. *Cupressus*, cf.
505 *Juniperus* and *Pinus* sp., is also of interest when thinking of the smoke and scent they can
506 produce, especially for ritual purposes. As for Krania, the represented forest types belong
507 mostly to mixed deciduous forest and woodland and shrubs, with additional presence of
508 *Phillyrea/Rhamnus*, *Phillyrea* sp., cf. *Populus* and cf. *Fraxinus*. Legumes and fruit trees
509 are also characteristic especially for the 8th century B.C (*Olea*, cf. *Ficus*, Pomoideae,
510 *Prunus* cf. *domestica*, Rosaceae, Anacardiaceae). The ritual activities that might have
511 occurred in the settlement are noticeable when looking at the wood charcoal identified, as
512 well as they bring evidences of the forest communities present in the surrounding of the
513 settlement and anthropogenic landscapes (Renault-Miskovsky and Thiébault 1997).

514

515

516 6. Concluding remarks

517

518 The charcoal assemblage from Krania adds considerably to our understanding of the
519 composition and exploitation of the woody environment surrounding the settlement.
520 Generally speaking, the assemblage presents a picture of a low and mid altitude woodland,
521 with oaks, pine trees, and maple as well as alder, hornbeam, dogwood, ash, plane tree,
522 poplar/willow, elm, and *Phillyrea*/buckthorn species. The forest community is primarily
523 characterized by dry resistant and thermophilous taxa (*Pinus* type), evergreen and
524 deciduous broad-leaved (*Quercus* spp., *Acer* sp. *Olea* sp., *Cercis* spp., *Arbutus unedo*,
525 *Ulmus* sp., *Phillyrea/Rhamnus*), mainly found on the hilly lowlands and coastal areas
526 (Spanos 2021). The surrounding environment of the settlement can be pictured with partly
527 forested areas, bushlands and grazing lands with partial erosion on the slopes due to
528 anthropic and natural impacts. Riparian taxa accompany the presence of running water in
529 the nearby environment of the settlement. Exploitation of wood might have been
530 undertaken within walking distance of the settlement, particularly on the hilly slopes
531 (average altitude of 200 m) where different forest communities coexisted. The
532 combination of running water and fruit tree species reinforces the idea of local cultivation,
533 which is also supported by the pollen records and the increase of crop production
534 (Margaritis 2007, Godefroy and Margaritis in preparation). Examining charcoal from
535 Krania demonstrates the capability of these ancient communities to adapt to their
536 environment by maintaining their lands while also exploiting wood resources. The
537 systematic study of charcoal provides a new element comprehending past communities,
538 encouraging for its use and further development within archaeological research.

539

540

541 Author contributions

542

543 Lou Godefroy: Conceptualization, Methodology, Formal analysis, Data curation, Writing
544 – Original draft. Aurélie Salavert: Conceptualization, Writing – Review & Editing,
545 Supervision. Evi Margaritis: Resources, Writing – Review & Editing.

546

547

548 Data availability

549

550 Raw data are accessible in table 1.

551

552

553 Declaration of competing interest

554

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

557

558

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560

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574 References

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577 Asouti E., Austin P., 2005. Reconstructing woodland vegetation and its exploitation by
578 Past Societies, based on the Analysis and Interpretation of Archaeological wood charcoal
579 macro-remains. *Environmental Archaeology* 10, 1-18.

580 Asouti, E., Kabukcu, C., 2014. Holocene semi-arid oak woodlands in the Irano-Anatolian
581 region of Southwest Asia: Natural or anthropogenic? *Quaternary Science Reviews* 90,
582 158–182.

583 Asouti, E., Kabukcu, C., 2021. Anthracology: Charcoal Science in Archaeology and
584 Palaeoecology. *Quaternary International* 593, 1-5.

585 Athanasiadis, N (1975): Zur postglazialen Vegetationsentwicklung von Litochoro
586 Katarinis und Pertouli Trikalon (Griechenland). *Flora*, 164, 99-132.

587 Athanasiadis, N., Gerasimidis, A., 1986. Zur postglazialen Vegetationsentwicklung des
588 Voras-Gebirges (Almopia – Griechenland) (In Greek). *Wiss. Jarb. Fak. Forstwiss nat*

589 Athanasiadis, N., Gerasimidis, A., 1987. Zur postglazialen Vegetationsentwicklung des
590 Paikon-Gebirges (Nord Griechenland) (In Greek). *Wiss. Jarb. Fak. Forstwiss nat Umwelt*
591 *Univ. Thessaloniki* 30, 403–445.

592 Athanasiadis, N., Tonkov, S., Atanassova J., Bozilova, E., 2000. Palynological study of
593 Holocene sediments from Lake Doirani in northern Greece. *Journal of Paleolimnology* 24
594 3, 331-342.

595 Banaszczak, P., 2010. The maples of Europe – Part 1. Vol 20.3, 6-7.

596 Broodbank C. 2013. *The Making of the Middle Sea, A History of the Mediterranean from*
597 *the Beginning to the Emergence*. Oxford, University Press.

598 Dimopoulos, P., Raus, Th., Bergmeier, E., Constantinidis, Th., Iatrou, G., Kokkini, S.,
599 Strid, A., Tzanoudakis, D., 2013. *Vascular plants of Greece: An annotated checklist. –*
600 *Berlin: Botanic Garden and Botanical Museum Berlin-Dahlem, Athens. Hellenic*
601 *Botanical Society, Englera* 31.

602 Bookidis N., Hansen J., Snyder L., Goldberg P., 1999. Dining in the sanctuary of Demeter
603 and Kore at Corinth. *Hesperia* 68.1.

604 Brust, M., 2017. *Les communautés végétales des interfaces forêt-prairie et leur*
605 *environnement face aux cas d'afforestation et de déforestation*. Ph-D, Université de
606 Lorraine.

607 Casson S., 1926. *Macedonia, Thrace and Illyria, their relations to Greece from the earliest*
608 *times down to the time of Philip son of Amyntas*. Oxford, University Press, Humphrey
609 Milford.

610 Chabal, L., Fabre, L., Terral, J.-F., and Théry-Parisot, I. 1999. L'anthracologie. In C.
611 Mignot, J.-E. Brochier, L. Chabal, S. Crozat, L. Fabre, F. Guibal, P. Marinval, J.-F. Terral
612 and I. Théry-Parisot (eds.), *La Botanique*, 43-104.

613 Chabal, L., Heinz, C., 2021. Reconstructing the heterogeneity of past woodlands in
614 anthracology using the spatial distribution of charcoals in archaeological layers: Applied
615 to the postglacial occupation of the Abeurador cave (Hérault) in the South of France.
616 *Quaternary International* 593–594, 19-35.

617 Chabal L., Kabukcu C., 2021. Sampling and quantitative analysis methods in anthracology
618 from archaeological contexts: achievements and prospects. *Quaternary International* 593-
619 594 (9), 6-18.

620 Chabal, L., 1997. Forêts et sociétés en Languedoc (Néolithique final, Antiquité tardive),
621 L'anthracologie, méthode et paléoécologie. Maison des Sciences de l'Homme, Documents
622 d'Archéologie Française, 63.

623 Crielaard, J.P., Kluiving S., Charalambidou X., Godefroy L., Sheik T.A., 2020. What went
624 into the Melting Pot? Land use, agriculture, and craft production as indicators for the
625 contributions of Greek migrants and local inhabitants to the so-called Greek colonization
626 in Italy (800-550 BC). In TMA 63, 49.

627 Foxhall, L. 1995. Bronze to iron: agricultural systems and political structures in late
628 bronze age and early iron age Greece. The Annual of the British School at Athens, 90,
629 239-250.

630 Foxhall, L., 2007. Olive Cultivation in Ancient Greece: Seeking the Ancient Economy.
631 Oxford, University Press.

632 Foxhall, L. 2015. Households, Hierarchies, Territories and Landscapes in Bronze Age and
633 Iron Age Greece. In The Cambridge Prehistory of the Bronze and Iron Age Mediterranean
634 (pp. 417-436). Cambridge University Press.

635 Gerasimidis, A., Panajiotidis, S. and Athanasiadis, N., 2008. Five decades of rapid forest
636 spread in the Pieria Mountains (N. Greece) reconstructed by means of high-resolution
637 pollen analysis and aerial photographs. Veget Hist Archaeobot 17, 639–652.

638 Gimatzidis S., M. Pieniazek and Mangaloglu-Votruba S. (eds.) 2018. Archaeology across
639 Frontiers and Borderlands. Vienna, Austrian Academy of Sciences Press.

640 Gimatzidis, S. 2020. The economy of early Greek colonization in the northern Aegean.
641 Journal of Greek Archaeology 5, 243-262.

642 Hammond N.G.L., 1972. A History of Macedonia. Volume 1. Historical Geography and
643 Prehistory. Oxford, The Clarendon Press.

644 Jacquiot C., 1955. Atlas d'anatomie des bois des conifères. 2 vol.

645 King, R., Proudfoot, L., and Smith, B. (eds), 1997. The Mediterranean: Environment and
646 Society. Arnold, London.

647 Kotthoff, U., Müller, U.C., Pross, J., Schmiedl, G., Lawson I.T., van de Schootbrugge, B.,
648 Schulz, H., 2008. Late glacial and Holocene vegetation dynamics in the Aegean region: an
649 integrated view based on pollen data from marine and terrestrial archives, Holocene 18,
650 1019-1032.

651 Lawson, I.T., Al-Omari S., Tzedakis, P.C., Bryant C.L., Christanis, K., 2005. Lateglacial
652 and Holocene vegetation history at Nisi Fen and the Boras mountains, northern Greece.
653 Holocene 15, 873-887.

654 Lentjes, D., 2015. A walk in the woods. Charcoal analysis from three Greek
655 archaeological sites: Geraki, Plakari and Titane. Pharos. Journal of the Netherlands
656 Institute at Athens 21 (2), 135-173.

657 Margaritis, E., 2005. Olive and vine farming in Hellenistic Pieria: an archaeobotanical
658 study of settlements from Macedonia, Greece. Ph-D thesis, Cambridge, Darwin College.

659 Margaritis, E., 2007. Archaeobotanical investigations at the geometric site of Krania,
660 Southern Pieria in Macedonia, Greece. TALANTA XXXVIII-XXXIX (2006-2007).

661 Margaritis, E., 2017. Domestic and ritual use of plants in Early Iron Age Greece. In A.
662 Mazarakis Ainian, A. Alexandridou, X. Charalambidou (eds.), Regional stories towards a
663 new perception of the early Greek world. Acts of an International Symposium in honour
664 of Professor Jan Bouzel, Volos, 18-21 June 2015.

665 Médail, F., 2008. Mediterranean. In S.E. Jorgensen (ed.), Encyclopedia of Ecology.
666 Cambridge University Press, Cambridge.

667 Médail, F., Monnet, A.-C., Pavon, D., Nikolić, T., Dimopoulos, P., Bacchetta, G., Arroyo,
668 J., Barina, Z., Albassatneh, M., Domina, G., Fady, B., Matevski, V., Mifsud, S., Leriche,
669 A., 2019. What is a tree in the Mediterranean Basin hotspot? A critical analysis. Forest
670 Ecosystems. 6. 10.1186/s40663-019-0170-6.

671 Pagnoux C. 2016. Émergence, développement et diversification de l'arboriculture en
672 Grèce du Néolithique à l'époque romaine : confrontation des données archéobotaniques,
673 morphométriques, épigraphiques et littéraires. Université Paris 1 Panthéon-Sorbonne,
674 thèse.

675 Pantera, A., Papadopoulos, A., Fotiagis, G., Papanastasis V. 2009. Distribution and
676 phytogeographical analysis of *Quercus ithaburensis* ssp. *macrolepis* in Greece, *Ecologia*
677 *Mediterranea*, 34, 73-82.

678 Polunin, O., 1987. Flowers of Greece and the Balkans, a Field Guide. Oxford, University
679 Press, Oxford and New York.

680 Poulaki-Pantermali, E., 2001. Έργα εθνικά και αλλά στην περιοχή του Μακεδονικού
681 Ολύμπου, *ΑΕΜΤΗ* 15, 331-346.

682 Poulaki-Pantermali, E., 2013. Μακεδονικός Όλυμπος: μύθος, ιστορία, αρχαιολογία.
683 Thessaloniki.

684 Pratt, C., 2021. Oil, Wine, and the Cultural Economy of Ancient Greece: From the Bronze
685 Age to the Archaic Era.

686 Quézel, P., Médail, F., 2003. *Écologie et biogéographie des forêts du bassin*
687 *méditerranéen*. Elsevier (collection environnement), Paris.

688 Renault-Miskovsky J., Thiébaud S. 1997. Apports des études paléobotaniques à la
689 connaissance de l'environnement végétal et à l'exploitation du territoire de Delphes
690 (Grèce) du XII^e à la fin du V^e av. notre ère. In *La dynamique des paysages*
691 *protohistoriques, antiques, médiévaux et modernes*. Actes des rencontres des 19-21 oct.
692 1996, Chouquer, 453-473.

693 Renfrew C. 1972. *The Emergence of Civilisation : the Cyclades and the Aegean in the*
694 *Third Millennium B.C.* London, Methuen.

695 Schepelmann R. 2017. *Flora Graeca* (Edition Kentavros).

696 Semple, E.C., 1932. *The Geography of the Mediterranean Region*. Constable, 86.

697 Spanos, K.A., Skouteri, A., Gaitanis, D., Petrakis, P.V., Meliadis, I., Michopoulos, P.,
698 Solomou, A., Koulelis, P., Avramidou, E.V., 2021. Forests of Greece, Their Multiple
699 Functions and Uses, Sustainable Management and Biodiversity Conservation in the Face
700 of Climate Change, *Open Journal of Ecology*, 11., 4, 374-406.

701 Strid, A., 1980. *Wild Flowers of Mount Olympus. – Kifissia: Goulandris Natural History*
702 *Museum*. xviii + 362 pp. incl. 109 colour plates. [Also in Greek: *Φυτά του Ολύμπου*,
703 translated by E. Economidou], 276.

704 Schweingruber 1990. *Anatomie microscopique du bois, identification de*
705 *matériel récent et subfossile d'essences de l'Europe centrale en tenant compte*
706 *de la variabilité de structure du bois de tronc et de branche*, 3^e édition, Teufen,
707 Birmensdorf : Kommissionsverlag F. Flück-Wirth, Institut fédéral de recherches
708 sur la forêt, la neige et le paysage.

709 Tal, O., 2006. Comparative flowering ecology of *Fraxinus excelsior*, *Acer platanoides*,
710 *Acer pseudoplatanus* and *Tilia cordata* in the canopy of Leipzig's floodplain forest.
711 Environmental Science.
712 Valamoti S., Gkatzogia E., Ntinou M., 2018. Did Greek colonization bring olive growing
713 to the north? An integrated archaeobotanical investigation of the spread of *Olea europaea*
714 in Greece from the 7th to the 1st millennium BC. *Vegetation History and Archaeobotany*,
715 27, 177-195.
716 Wagner, B., Lotter, A.F., Nowaczyk, N., Reed, J.M., Schwalb, A. Suipizio, R., Valsecchi,
717 V., Wessels, M., Zanchetta, G., 2009. A 40.000-year record of environmental change from
718 ancient Lake Ohrid (Albania and Macedonia). *Journal of Paleolimnology* 41, 407-430.
719 Zhang, X., Reed, J., Wagner, B., Francke, A., Levkov, Z., 2014. Lateglacial and Holocene
720 climate and environmental change in the northeastern Mediterranean region: diatom
721 evidence from Lake Dojran (Republic of Macedonia/Greece), *Quaternary Science*
722 *Reviews*, 103, 51-66.

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725 Figure captions/Table captions

726

727 Fig. 1. Location of the Krania settlement in Southern Pieria, Macedonia, Greece (map by
728 J. Fokkema).

729

730 Fig. 2. A: Position of the Krania settlement at the foot of Platamon Hill (CAD by L.
731 Godefroy). B: Excavation drawing that shows the different buildings, pebble floors and
732 pits (E. Poulaki-Pantermali 2013).

733

734 Fig. 3. A: Picture of the oval building from the 8th century B.C. (E. Poulaki-Pantermali
735 2013). B: Artist's impression of a single-room building from Krania (E. Poulaki-
736 Pantermali 2013).

737

738 Fig. 4. SEM macrophotographs of anatomical sections of Iron Age wood from Krania
739 (photos by L. Godefroy). A-C: transverse, tangential and radial sections of pine tree
740 (*Pinus cf. sylvestris/nigra*). D-F: transverse section of *Quercus sp.* deciduous, transverse
741 section of *Quercus sp.* evergreen, tangential section of oak (*Quercus sp.* deciduous). G-I:
742 transverse, tangential and radial sections of judas tree (*Cercis sp.*). J-L: Transverse,
743 tangential and radial section of cornelian cherry (*Cornus mas*). M-O : Transverse,
744 tangential and radial section of olive tree (*Olea europaea*).

745

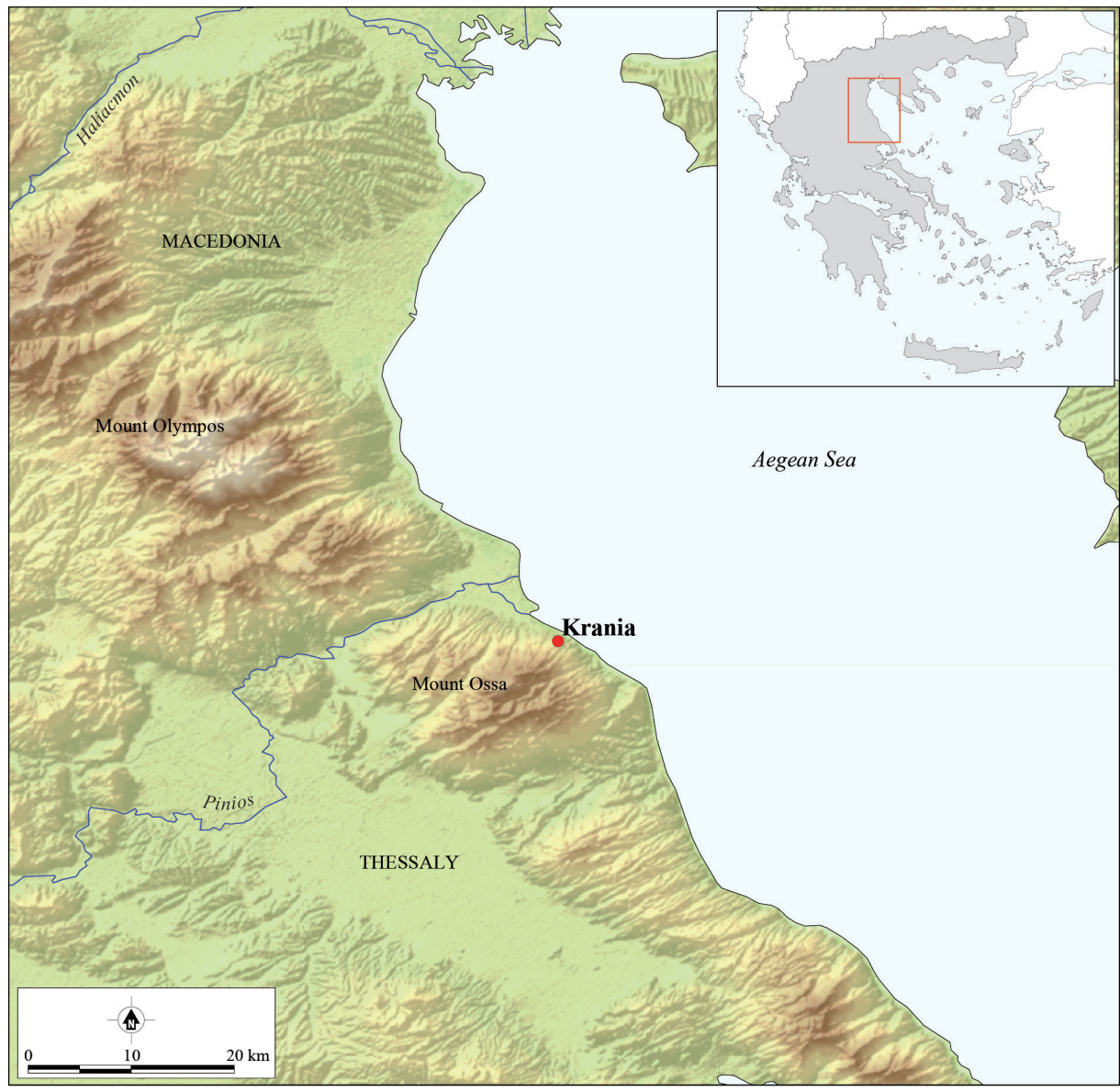
746 Fig. 5. Theoretical transect of the vegetation in the surrounding of the settlement of Krania
747 (transect by L. Godefroy).

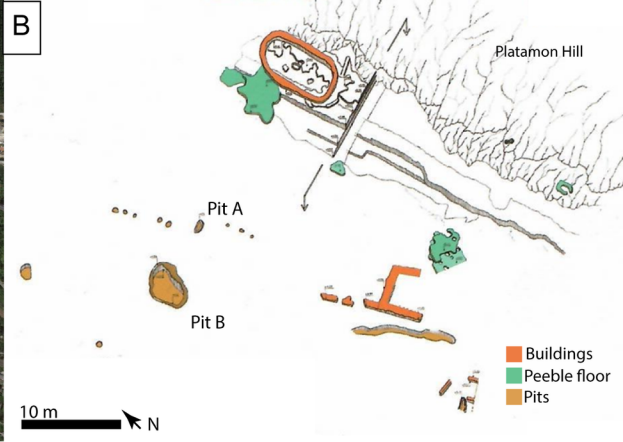
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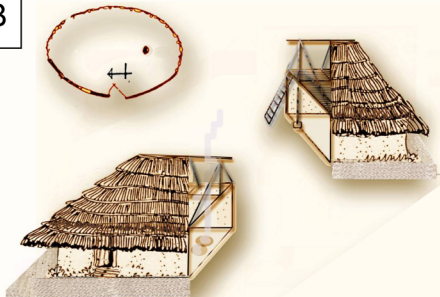
749 Table 1. Identification table of charcoal identified at Krania per samples (analyses by L.
750 Godefroy).

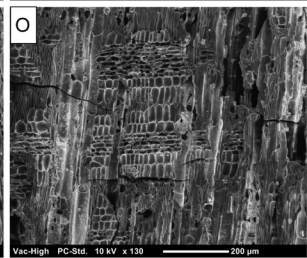
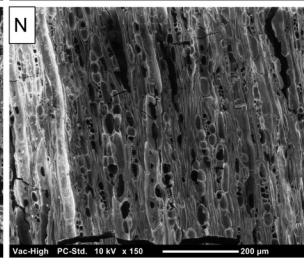
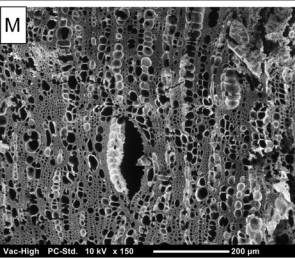
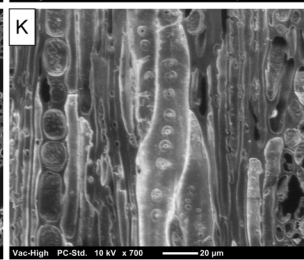
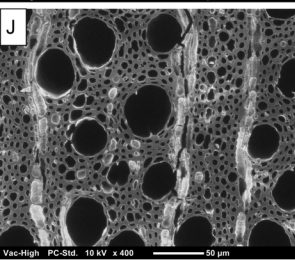
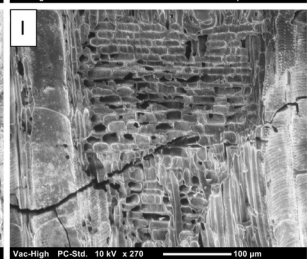
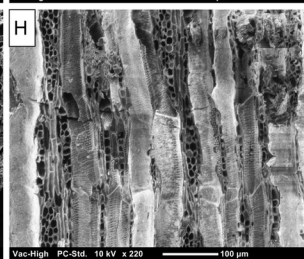
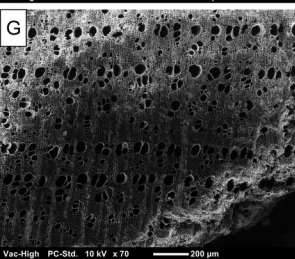
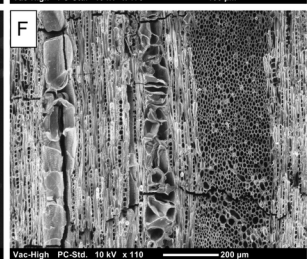
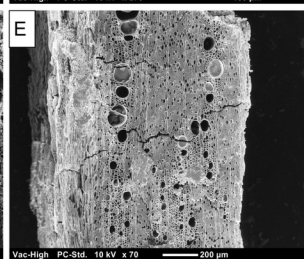
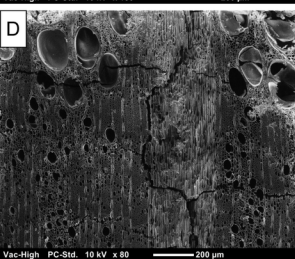
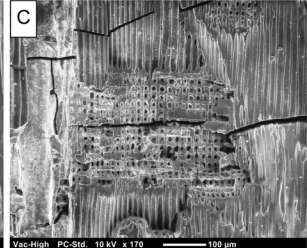
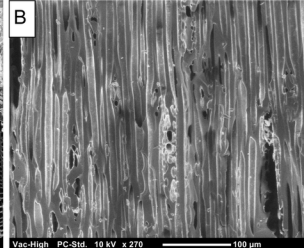
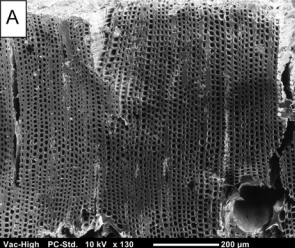
751

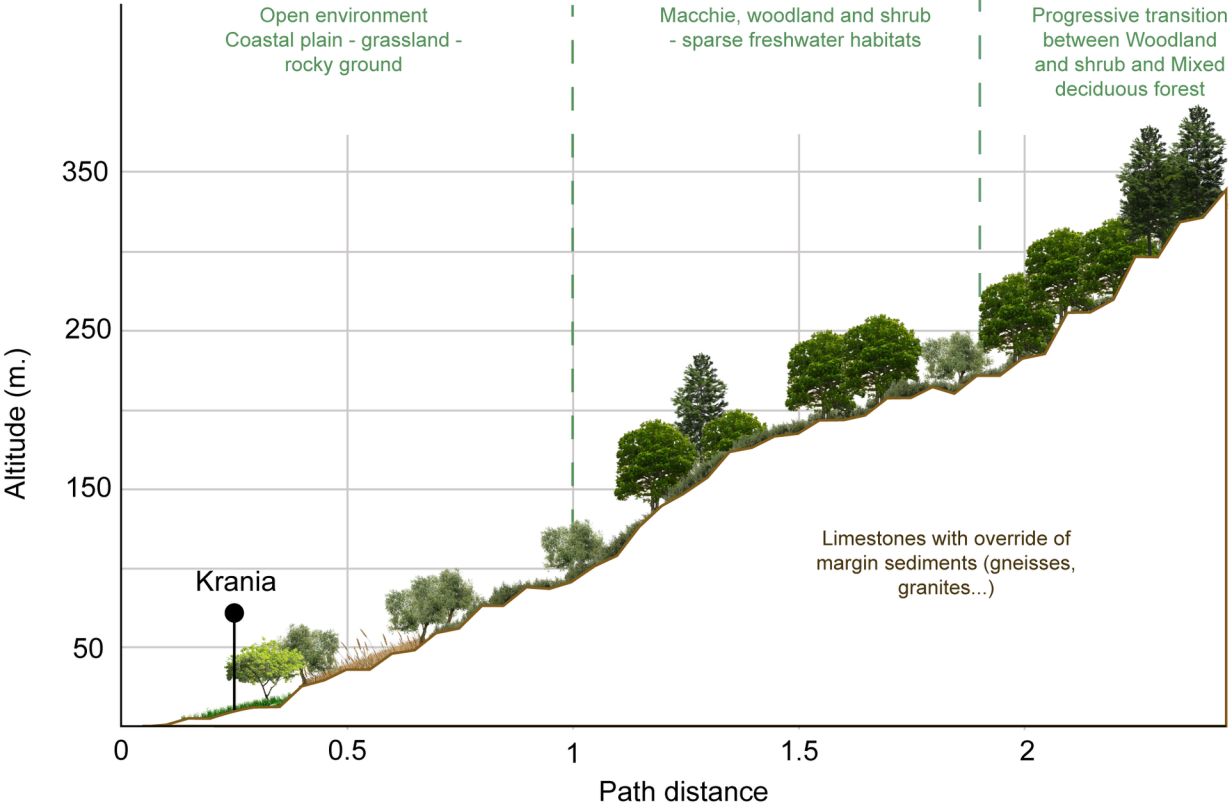
752





A**B**





Site : Krania Director : E. Poulaki- Pantermali Year : 2001	Sector	IV	IV	IV	IV	IV	IV	IV	IV	IV	IV	IV	IV	III	Total		
	Trench	12D	12D	12D	12D	12D	12D	12D	12D	12D	12D	12D	12D	11C 1D			
	Stratum	E6	E6	E6	E6				E6	E6	E6	3A/3C					
	US	NK58	NK74	NK87	NK90	NK93 X	NK96	NK103	NK124	NK135 X	NK146 X	NK185		NK280			
	Volume (cm3)			2 bags		20L				24L	10L	32L		12-18L			
	Period	Geometric	Geometric	Geometric	Geometric	Geometric	Geometric	Geometric	Geometric	Geometric	Geometric	Geometric		Geometric			
	Structure	Pit A	Pit A	Pit A	Pit A	Pit A	Pit A	Pit A	Pit A	Pit A	Pit A	Pit A	Pit A total	Pit A		Pit B	
		n/frgm.	n/frgm.	n/frgm.	n/frgm.	n/frgm.	n/frgm.	n/frgm.	n/frgm.	n/frgm.	n/frgm.	n/frgm.	n/frgm.	Relative frequency	n/frgm.	Relative frequency	
<i>Acer</i> sp.	Maple	1	1	1		1	3	1	5	7			20	10%	15	21%	35
cf. <i>Acer</i>	cf. Maple												0	0%	2	3%	2
<i>Alnus</i> sp.	Alder								1				1	1%		0%	1
<i>Arbutus unedo</i>	Strawberry tree					1			1				2	1%	3	4%	5
<i>Carpinus</i> sp.	Hornbeam	1											1	1%		0%	1
<i>Cercis</i> sp.	Judas tree, Redbud								1	1			2	1%	2	3%	4
<i>Cornus</i> sp.	Dogwood											4	4	2%	1	1%	5
<i>Cornus mas</i>	Cornelian cherry											21	21	11%	6	8%	27
<i>Fraxinus</i> sp.	Ash	9		1							1	1	12	6%	1	1%	13
<i>Olea europaea</i>	Olive tree				1			2			1	10	14	7%	3	4%	17
cf. <i>Olea europaea</i>	cf. Olive tree											1	1	1%	2	3%	3
<i>Pinus</i> cf. <i>sylvestris/nigra</i>	cf. Baltic pine/Black pine	1	5	7		4	12	1	4	1			35	18%	9	13%	44
cf. <i>Pinus</i>	cf. Pine								2	1			3	2%	1	1%	4
<i>Pinus</i> cf. <i>peuce</i>	cf. Macedonian pine	1			4	1			4				10	5%		0%	10
<i>Platanus</i> sp.	Plane tree	2		1				1	1	2			7	4%		0%	7
<i>Populus / Salix</i>	Poplar / Willows		2										2	1%		0%	2
<i>Quercus</i> sp.	Oak			1					4				5	3%	4	6%	9
cf. <i>Quercus</i>	cf. Oak												0	0%	1	1%	1
<i>Quercus</i> sp.	Oak sp. deciduous		2	2		2	3	5	8			2	24	12%	7	10%	31
<i>Quercus</i> sp.	Oak sp. evergreen	1		5		3	2	4	4			1	20	10%	4	6%	24
<i>Phillyrea/Rhamnus</i>	<i>Phillyrea</i> /Buckthorn			4								1	5	3%	1	1%	6
cf. <i>Phillyrea/Rhamnus</i>	cf. <i>Phillyrea</i> /Buckthorn								1				1	1%		0%	1
cf. <i>Salix</i>	cf. Willows			1									1	1%		0%	1
<i>Ulmus</i> sp.	Elm												0	0%	2	3%	2
Oleaceae									1				1	1%	1	1%	2
Moraceae													0	0%	1	1%	1
Maloideae													0	0%	1	1%	1
Indeterminata	Undetermined					2	1		2				5	3%	5	7%	10
Total		16	10	23	5	14	21	14	38	13	2	41	197	100%	72	100%	269