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1 New evidence of bone tool use by Early Pleistocene hominins from Cooper's D, Bloubaan
2 Valley, South Africa

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21 **Abstract**

22 Bone tool-use by Early Pleistocene hominins is at the center of debates in human evolution. It
23 is especially the case in South Africa, where 102 bone tools have been described from four
24 Early Stone Age (ESA) archaeological sites, which have yielded Oldowan and possibly
25 Acheulean artefacts, as well as *Paranthropus robustus* and early *Homo* remains. Here we
26 describe a bone tool from Cooper's D. The deposit, dated between 1.4 and 1.0 Ma, has
27 yielded seven *P. robustus* remains and 50 stone artefacts. Our results highlight similarities in
28 morphology and use-wear patterns between the Cooper's D bone tool and those previously
29 identified at nearby Sterkfontein, Swartkrans, Kromdraai and Drimolen. Our findings increase
30 the number of Early Stone Age bone tools and provide further evidence of their association
31 with *P. robustus*. They suggest *P. robustus* had the cognitive capacities to develop this
32 cultural adaptation and the manipulative abilities to implement it.

33 **1. Introduction**

34 Although formal bone tools, i.e. tools entirely or almost entirely shaped with techniques
35 specifically conceived for bone material such as scraping, grinding and grooving, are well
36 known in the Eurasian Upper Palaeolithic and the African Later Stone Age, it is only in the
37 last twenty years that we have begun to have information on the origin of this cultural
38 innovation (Backwell and d’Errico, 2001; d’Errico et al., 2012, 2020). Early instances are
39 found at Middle Stone Age sites from southern, northern, and central Africa (Brooks et al.,
40 1995, 2006; Yellen et al., 1995; Henshilwood et al., 2001; Backwell et al., 2008, 2018;
41 d’Errico et al., 2012, 2020; El Hajraoui and Debénath, 2012; Backwell and d’Errico, 2015).
42 More debated issues concern the first use of bone modified with techniques generally applied
43 to stone such as knapping (Backwell and d’Errico, 2004; Zutovski and Barkai, 2016; Doyon
44 et al., 2020; Pante et al., 2020; Porraz et al., 2020), and the use of minimally modified bone
45 fragments. Ever since the discovery of the species *Australopithecus africanus*, referred to then
46 as *A. prometheus*, Dart (1949, 1957, 1959a, b, 1960, 1961a, b, 1962) proposed that this
47 hominin was able to use bone as a tool. He referred to the bone collection from Makapansgat
48 as the “osteodontokeratic culture”. Dart’s ‘bone tool’ hypothesis was challenged by the work
49 of Brain (1967a, 1967b, 1976, 1981), Mills (1973), Mills & Mills (1977), Skinner (1976) and
50 Klein (1975), who emphasized the role of natural agents, particularly hyaena, in the
51 production of pseudo-tools. While maintaining his opinion on the highly questionable nature
52 of the Makapansgat “bone tools”, it was the same Brain who published the discovery of 68
53 bone tools from the hominin site of Swartkrans (Brain & Shipman 1993). Since then,
54 evidence for the existence of an early bone tool technology at Early Stone Age (ESA) sites in
55 South Africa has grown (Brain, 1967; Brain et al., 1988; Brain and Shipman, 1993; Backwell,
56 2000; Backwell and d’Errico, 2001, 2001, 2003, 2005, 2008; d’Errico et al., 2001; d’Errico

57 and Backwell, 2003, 2009; Stammers et al., 2018). A growing body of data indicate that these
58 tools mostly consist of weathered limb bone shaft fragments of medium to large size animals
59 with a worn and polished area at the tip (Brain and Shipman, 1993; Backwell and d’Errico,
60 2001, 2008). According to d’Errico et al. (2001) and Backwell and d’Errico, (2001),
61 Swartkrans bone tools are characterized by a single rounded end with a smoothed/polished
62 area ranging from 5 to 50 mm from the tip. At microscopic scale, 5-40 μm wide sub-parallel,
63 overlapping striations oriented along the main axis of the tool cover the smoothed area.
64 Broader striations are visible, transverse to the main axis of the bone, with a width ranging
65 from 100 to 400 μm . These bones mainly derived from medial portions of long bone shafts
66 from medium (size-class II-III) to large-size (size-class III-IV) class mammals (Brain and
67 Shipman, 1993; Backwell and d’Errico, 2003). They have been interpreted as digging sticks
68 used to forage for termites and plant roots, and possibly to process fruit (d’Errico and
69 Backwell, 2009). To date, four South African sites have yielded definitive evidence of early
70 hominin bone tool technology, namely Sterkfontein, Swartkrans, Drimolen and Kromdraai, all
71 situated in the Cradle of Humankind UNESCO World Heritage Site, located northwest of
72 Johannesburg (Figure 1).

73 Here, we provide a description of the first bone tool from the *P. robustus*-bearing deposit of
74 Cooper’s D. This site is dated between 1.4 and 1.0 Ma (see below), a timespan that fills the
75 chronological gap between Swartkrans Members 2 and 3. This paper also provides
76 descriptions of associated pseudo-tools from Cooper’s D, some of which feature a similar
77 rounded tip morphology, but lacking diagnostic traces of utilisation, and a discussion of South
78 African ESA bone tools.

79 **1.1. Bone tools from Early Stone Age deposits in South Africa**

80 Robinson (1959) was a pioneer as he was the first to identify a bone tool from the Cradle of
81 Humankind, from Sterkfontein Member 5 West, Acheulean Infill. In his original paper in
82 1959, this author proposed that *Telanthropus* (attributed today to *Homo*) was the most
83 probable stone and bone toolmaker. The deposit has been dated by paleomagnetism to
84 between 1.3 and 1.1 Ma, and has yielded *Homo* remains associated with Acheulean stone tool
85 technology (Kuman and Clarke, 2000; Herries and Shaw, 2011). Subsequent studies provided
86 descriptions of additional bone tools from the site of Swartkrans Members 1 to 3 (Brain et al.,
87 1988; Brain, 1993; Brain & Shipman 1993; Backwell and d’Errico, 2001, 2003; d’Errico and
88 Backwell, 2003), and then from Drimolen (Backwell and d’Errico 2008), Krombraai B
89 (Stammers et al., 2018) and possibly the Sterkfontein Name Chamber (Val and Stratford,
90 2015). Based on these studies, 102 bone tools have been identified at four South African early
91 hominin sites.

92 The bone tool-bearing deposits cover a time span of almost one and a half million years (2.4-
93 0.96 Ma). Drimolen Main Quarry (MNQ) has been recently dated *c.* 2.04 – 1.95 Ma (Herries
94 et al., 2020). In the MNQ, the bone tools are associated with both *Homo* and *Paranthropus*
95 *robustus* remains, as well as Oldowan stone artefacts (Keyser et al., 2000; Moggi-Cecchi et
96 al., 2010; Stammers et al., 2018). A similar situation occurs for Swartkrans Member 1 (Brain,
97 1993; d’Errico and Backwell, 2003; Caruana, 2017), which is dated between 2.4 and 1.8 Ma
98 (Pickering et al., 2019). In Member 2 of Swartkrans, dated *c.* 1.4 Ma, an Acheulean stone tool
99 industry is found associated with bone tools and both *Homo* and *P. robustus* remains (Brain,
100 1993; d’Errico and Backwell, 2003; Kuman, 2007; Balter et al., 2008). The largest collection
101 of bone tools was found in Swartkrans Member 3, which is dated *c.* 0.96 Ma, associated with
102 an Acheulean Industry and only *P. robustus* remains (Brain, 1993; d’Errico and Backwell,
103 2003; Kuman, 2007; Gibbon et al., 2014). Two bone tools have been described from the

104 Kromdraai B site, which has yielded only two stone tools and *P. robustus* remains (Kuman,
105 2007; Braga et al., 2017; Stammers et al., 2018). The age of this deposit is unresolved, but it
106 is thought to be >2.2 Ma (Bruxelles et al., 2017). Finally, one bone tool is reported from the
107 newly excavated area of the Sterkfontein Name Chamber (Val and Stratford, 2015), but we
108 still lack photographic evidence supporting its identification, and the age of the deposit is
109 unclear; a mixture of Members 4 (2.95-1.95 Ma; Pickering and Kramers, 2010) and 5 East
110 Oldowan (2.18±0.21 Ma; Granger et al., 2015).

111 **1.2. Cooper's D site**

112 Cooper's Cave is located in the UNESCO Sterkfontein, Swartkrans, Kromdraai and Environs
113 World Heritage Site in South Africa, at 1.5 km northeast of Sterkfontein, 1 km southwest of
114 Kromdraai, and 45 km northwest of Johannesburg (Figure 1) (Berger et al., 2003; de Ruiter et
115 al., 2009). These cave deposits occur on dolomite of the Monte Cristo Formation (Malmani
116 Subgroup, Transvaal Supergroup) and yield abundant fossil assemblages in both calcified and
117 decalcified breccias (Berger et al., 2003; Steininger et al., 2008; de Ruiter et al., 2009).

118 Excavations at Cooper's between 2001 and 2009, were conducted in decalcified sediments,
119 which has preserved an abundant fossil assemblage of large and small vertebrates (n
120 >50,000), stone tools (n = 49), and seven hominin remains, six of them attributed to
121 *Paranthropus robustus* (Berger et al., 2003; Steininger et al., 2008; de Ruiter et al., 2009;
122 Sutton et al., 2017). The first radiometric uranium-lead (U-Pb) dates estimated the age of the
123 basal speleothem to be 1.526±0.088 Ma (de Ruiter et al., 2009). A flowstone layer situated in
124 the middle of the deposit was dated to c. 1.4 Ma. A more recent study based on the resampling
125 of the basal speleothem for U-Pb dating gives an age of the basal speleothem to be
126 1.375±0.113 Ma (Pickering et al., 2019). A minimum age of 1.0 Ma for the deposit is

127 proposed by Hanon (2019), based on biochronological data from the large mammal
128 assemblage. Thus, we assume that the Cooper's D material from decalcified sediments
129 accumulated between *c.* 1.4 and 1.0 Ma.

130 Two previous taphonomic studies were conducted on large mammal sub-assemblages at
131 Cooper's D (de Ruiter et al., 2009; Val et al., 2014). The first one focused on a sub-sample of
132 the large mammal assemblage, and suggested that a hyaenid – particularly the brown hyaena
133 (*Parahyaena brunnea*) – was the main accumulating agent of the faunal deposit (de Ruiter et
134 al., 2009). The second study relied on the large-bodied primate assemblage to suggest that
135 both leopards and hyaenas were the most probable accumulating agents (Val et al., 2014).
136 These two studies did not report any bone surface modifications consistent with damage
137 produced by hominins through carcass exploitation or the use of bone tools.

138 The first extensive taphonomic study of the Cooper's D large mammal assemblage, conducted
139 by one of us (Hanon, 2019), led to the identification of butchery marks and potential bone
140 tools that are the subject of the present study.

141 **2. Materials and methods**

142 Between 2017 and 2018, we undertook a taphonomic study of the entire large mammal faunal
143 assemblage, composed of 21,193 specimens housed at the Evolutionary Studies Institute,
144 University of Witwatersrand, Johannesburg. For our anatomical and taxonomic
145 identifications, we used the modern osteological collection housed in the same institution. We
146 also compared Cooper's material to the modern collections and fossil assemblages from
147 Sterkfontein, Swartkrans and Kromdraai, housed at the Ditsong National Museum of Natural
148 History, Tswane (formerly Pretoria). Potential bone tools identified during the taphonomic
149 study of the Cooper's D assemblage were macro- and microscopically compared with

150 previously identified bone tools from Swartkrans housed at the Ditsong National Museum of
151 Natural History, and those published from Sterkfontein, Drimolen and Kromdraai.

152 All specimens from the large Cooper's D faunal collection were observed using an Olympus
153 SZ51 binocular microscope (10-40x magnification). We recorded the following bone
154 modifications: fracture pattern, weathering stage, cortical preservation state, abrasion and
155 polish, manganese coating, decalcification, concretion, compaction, carnivore and rodent
156 tooth marks, trampling and butchery marks, microbial damage and insect modification. These
157 identifications were made based on criteria developed by several authors (e.g. Behrensmeier,
158 1978; Binford, 1978; Brain, 1980, 1981; Maguire et al., 1980; Potts and Shipman, 1981;
159 Shipman and Rose, 1983, 1983; Behrensmeier et al., 1986; Hill, 1987; Blumenschine, 1988;
160 Blumenschine and Selvaggio, 1988; Olsen and Shipman, 1988; Fiorillo, 1989; Cruz-Uribe,
161 1991; Villa and Mahieu, 1991; Lyman, 1994; Blumenschine et al., 1996; Patou-Mathis, 1997;
162 Kaiser, 2000; Pickering, 2002; Domínguez-Rodrigo et al., 2009, 2010; Kuhn et al., 2010;
163 Backwell et al., 2012; Fourvel, 2012; Bountalis and Kuhn, 2014; Huchet, 2014; Parkinson,
164 2016). The results of this comprehensive taphonomic analysis will be published elsewhere
165 (Hanon et al., in prep.). This led us to identify 12 possible bone tools featuring morphological
166 characters matching, to some extent, those published by Backwell and d'Errico (2001, 2004)
167 and Pante et al. (2020). These pieces were photographed with a Dino-Lite AD7013MTL
168 digital microscope (20-100x magnification) and an Olympus SZX 16 multifocal microscope
169 coupled to a digital camera (7-115x magnification).

170 Selected areas of these specimens were moulded with a silicone dental elastomer (Coltène
171 President light body) and analysed with the Tescan Vega 2 LSU scanning electron microscope
172 (SEM) housed at the *Muséum national d'Histoire naturelle* electron microscopy and
173 microanalysis technical platform, Paris. The resin replicas were not metal coated, and all the

174 images were taken using 15.00 kV, 25 Pa and a view field ranging from 15 to 1 mm with a
175 LVSTD detector. Transparent replicas were made with the MA2+ resin (PRESI, France).
176 These casts were examined in reflected and transmitted light using a motorized Leica Z6
177 APOA microscope equipped with a DFC420 digital camera and the Leica Application Suite
178 (LAS) software, including the multifocal module (4-40x magnification). This microscope
179 used digital images acquired at variable heights and combined them to obtain a single
180 composite image with an extensive depth of field. As a reference we used descriptions and
181 images of early hominin bone tools from South Africa provided by the literature, and
182 experimental counterparts used in tasks such as digging in different sedimentary
183 environments, digging for termites, plant roots, and fruit processing (Backwell and d'Errico,
184 2001, 2004, 2008; d'Errico and Backwell, 2003, 2009).

185 **3. Results**

186 Examination of the 21,193 large mammal bone specimens resulted in the selection of 12
187 potential bone tools (Table 1). Two bones were identified as fragments of bovid metapodials.
188 The rest of the specimens are unidentifiable to taxonomic level and skeletal element. Most of
189 the bones belong to size class I and II mammals (n = 9/12, Table 2). This small assemblage is
190 composed of well-preserved specimens with no sign of abrasion (n=8/12), as well as very
191 abraded bone fragments (n=4/12, Table 3). No modification by biological agents was
192 identified. Morphometric data on each specimen are provided in Table 1.

193 The two limb shaft fragments CD.9977 and CD.3046C (Figure 2) have bevelled edges that
194 appear to be the result of fresh bone fracture. These specimens are characterized by the
195 presence of contiguous micro flake scars along their sides. The sharpness of the edges,
196 however, indicates the flake scars may result from post-depositional processes such as

197 trampling or sediment compression. Six other specimens (CD.343, CD.3528, CD.7900,
198 CD.3529, CD.1649, CD.15631) mimic the general morphology of bone tools found at early
199 Pleistocene hominin sites (Figure 3). However, at microscopic scale, we were not able to
200 identify the diagnostic use-wear pattern associated with the fossil tools, and the smoothing
201 present on them generally extends to the entire bone surface, which is consistent with the
202 action of a natural agent such as water abrasion.

203 CD.3538 (Figure 3d) is a limb bone shaft fragment with a morphology similar to that of early
204 Pleistocene hominin bone tools. However, no typical use-wear pattern is visible at a
205 microscopic scale, and the preservation of the periosteal surface is more consistent with that
206 resulting from a digestion process. For these reasons we identified this specimen as modified
207 by a carnivore.

208 CD.6978A (Figure 4a) is a fragment of a small bovid metapodial (size class II). One end is
209 bevelled, while the other shows a transverse fracture on dry bone. A crack parallel to the main
210 axis of the bone structure is visible on its periosteal surface. We attribute this crack to a
211 potential post-depositional process rather than to weathering, since no other evidence of
212 exposure is observable on the bone. The specimen has a manganese coating. The general
213 morphology is very similar to that of bone tools identified at Swartkrans, Drimolen and
214 Kromdraai, but we did not observe the use-wear pattern found on the bone tools from these
215 sites (Figure 4b).

216 CD.1293 (Figure 4c) is an indeterminate long bone shaft fragment attributed to a size class II
217 mammal. The piece is bevelled with a slightly smoothed end. Dry breakage is observed at the
218 opposite end as well as stage 1 weathering. However, the absence of microstriations and

219 polish restricted to the area of the tip does not permit us to identify this specimen as a bone
220 tool (Figure 4d).

221 Only one specimen can be confidently identified as a bone tool. CD.7895 (Figures 5-7) is a
222 fragment of an indeterminate long bone characterized by a rounded end. The other end has a
223 dry bone fracture. The general morphology of the fragment may correspond to a bovid
224 metapodial. The piece belongs to an animal of size class 2. The use-wear pattern is visible
225 from the tip for 28.9 mm along the edge, medullary and periosteal surfaces of the bone
226 (Figures 5-7). The microstriae are clearly visible on both multifocal and SEM photographs
227 (Figures 5-7). They are mostly longitudinal or oblique to the main axis of the long bone and
228 appear, as on well-preserved specimens from Swartkrans and Drimolen, to result from
229 abrasion by individual particles, each following a slightly different trajectory and marking
230 successively the bone surface. Microstriation widths are highly variable, ranging from 25 to
231 300 μm . However, very few striations with a width $>45 \mu\text{m}$ can be observed. Most of them
232 are curved and subparallel to the main axis of the bone. Longitudinal thin cracks indicate the
233 bone was at a weathering stage 1 when it was used as a tool.

234 **4. Discussion**

235 During our taphonomic investigation of the large mammal collection from Cooper's D, we
236 were able to identify 12 specimens as bone tools or pseudo-tools. However, after close
237 microscopic examination, only one specimen can be securely identified as a bone tool. The
238 remaining 11 pieces are interpreted as pseudo-tools produced by non-human post-depositional
239 processes, or tools so heavily affected by natural processes that their identification as
240 implements is impossible.

241 The CD.7895 bone tool from Cooper's D bears features (i.e. rounded and strongly polished
242 end associated with longitudinal or oblique microstriae between 25 to 300 μm wide) identical
243 to those identified on bone tools from the Sterkfontein, Swartkrans, Drimolen and Kromdraai
244 sites (Backwell and d'Errico, 2008; d'Errico and Backwell, 2009; Stammers et al., 2018). At
245 Cooper's D, the faunal material is dominated by small to medium size class mammals
246 (Hanon, 2019) and the only bone tool specimen is attributed to a size-class II mammal. At
247 Sterkfontein and Swartkrans, mammal size class II-III and III-IV dominate the bone tool
248 assemblage, while at Drimolen, the size class II-III is dominant and the mammals over or
249 under this size class are underrepresented. The bone tool from Cooper's D has been made on a
250 bovid metapodial, which is consistent with the trend observed at Swartkrans and Drimolen,
251 where the majority of the bone tools were obtained from long bone shaft fragments (Backwell
252 and d'Errico, 2003, 2008). Unlike these assemblages, we found no bone tools made from
253 horncores, mandibles or ribs. This is not surprising, however, if one considers that they occur
254 at the two sites in very low proportions.

255 The wear-pattern observed on the tip of the CD.7895 specimen from Cooper's D is very
256 similar to that recorded on bone tools from Sterkfontein, Swartkrans and Drimolen (Backwell
257 and d'Errico, 2008). Originally, these bone tools were interpreted as digging implements to
258 dig up tubers (Brain and Shipman, 1993). Subsequent quantitative study and comparison
259 between archaeological and experimental specimens lead some authors to suggest that these
260 bone tools were used for termite foraging (Backwell and d'Errico, 2001, 2008; d'Errico et al.,
261 2001). Subsequently, more detailed analysis of the bone surface texture indicated that even
262 though termite foraging is the most likely task for the Drimolen bone tools, other foraging
263 activities such as fruit processing and extraction of tubers could also be possible (d'Errico and
264 Backwell, 2009). It is difficult, at this stage, to assess the function of the bone tool from

265 Cooper's D, but given the orientation and fine width of the striations we propose termite
266 foraging as most likely.

267 Bone tools from Swartkrans Member 1 (n = 32), which is dated between 2.249 ± 0.077 –
268 1.706 ± 0.069 Ma, is associated with the Oldowan stone tool industry, *P. robustus* and *H. cf.*
269 *erectus* (Backwell and d'Errico, 2001, 2003; d'Errico and Backwell, 2003; Caruana, 2017;
270 Pickering et al., 2019). According to Herries et al. (2020) the depositional age of Swartkrans
271 Member 1 remains uncertain, and based on ESR dates and faunal evidence could have
272 occurred somewhere between 2.4 and 1.8 Ma, most likely 1.8 Ma. Based on this assertion,
273 Drimolen MNQ, recently dated between 2.04 – 1.95 Ma, could represent the oldest
274 occurrence in southern Africa of bone tools (n = 14), stone tools, *Homo* and *Paranthropus*
275 (Herries et al., 2020). The bone tools apparently disappear around 0.96 Ma, with the last
276 occurrence in Swartkrans Member 3 (n = 41; Brain, 1993; Backwell and d'Errico, 2003). This
277 implies that bone tools are known in South Africa from at least 2.4 to 0.96 Ma. During this
278 time, five sites have yielded definitive evidence of bone tool technology (Table 4). The
279 Cooper's D assemblage fills the chronological gap between Swartkrans Members 2 and 3. At
280 Cooper's D, *P. robustus* is the only hominin identified (Steininger et al., 2008; de Ruiter et
281 al., 2009). According to Sutton et al. (2017), there are 49 stone artefacts from Cooper's D, but
282 this small assemblage does not permit allocating them to a specific industry. Although two
283 bone tools are reported from the Kromdraai B deposit (Stammers et al., 2018), there is an
284 absence of clear radiometric dates. A second bone tool has been reported from Sterkfontein,
285 from the Name Chamber (Val and Stratford, 2015), and while a detailed study of this
286 specimen is lacking, it confirms a bone tool technology at this site.

287 We agree with Stammers et al. (2018) that an overall study of these sites shows no clear
288 pattern of associations with bone tools, not with hominins or stone tool industry. Bone tools

289 are associated with Oldowan as well as Acheulian stone tool industries in deposits containing
290 *P. robustus* and early *Homo* remains (Table 4). Some authors have suggested a link between
291 the presence of *P. robustus* and the early bone tools (Brain, 1993; Backwell and d’Errico,
292 2003, 2008). Indeed, the largest collection of ESA bone tools has been discovered in
293 Swartkrans Member 3, which is rich in *Paranthropus* remains (Brain, 1993). Drimolen MNQ
294 has also yielded a large number of *P. robustus* remains associated with a collection of bone
295 tools (Backwell and d’Errico, 2008). Finally, South African bone tools disappear after 0.96
296 Ma in Swartkrans Member 3, as is the case for both *P. robustus* and early *Homo*. We can
297 assume that the most parsimonious hypothesis is that *Paranthropus* may have been the user of
298 the bone tools, but the presence of *Homo* complicates the picture (Backwell and d’Errico,
299 2008; Stammers et al., 2018; Herries et al., 2020).

300 **5. Conclusion**

301 In this study we identify and describe the first bone tool from the Cooper’s D faunal
302 assemblage. The general morphology and use-wear pattern observed at the tip of the Cooper’s
303 D bone tool are very similar to that observed on bone tools from Sterkfontein, Swartkrans and
304 Drimolen. It has been shown that these tools were probably used to forage for termites and
305 plant roots and to process fruits. Based on the longitudinal orientation of the fine striations at
306 the tip of the specimen we tentatively propose that it was used in termite foraging, but wish to
307 investigate further this issue in the future. The fact that *P. robustus* is the only hominin
308 identified at Cooper’s D supports the hypothesis that *P. robustus* probably used the bone tool
309 (Brain, 1993; Backwell and d’Errico, 2001, 2003).

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325 **References**

- 326 Backwell, L.R., d’Errico, F., 2001. Evidence of termite foraging by Swartkrans early
327 hominids. *Proceedings of the National Academy of Sciences*. 98, 1358–
328 1363. Backwell, L., Bradfield, J., Carlson, K.J., Jashashvili, T., Wadley, L., d’Errico,
329 F., 2018. The antiquity of bow-and-arrow technology: evidence from Middle Stone
330 Age layers at Sibudu Cave. *Antiquity*. 92, 289–303.
- 331 Backwell, L., d’Errico, F., 2005. The origin of bone tool technology and the identification of
332 early hominid cultural traditions. In: d’Errico, F., Backwell, L. (Eds.), *From Tools to*

- 333 Symbols: From Early Hominids to Modern Humans. Wits University Press,
334 Johannesburg, pp. 238–275.
- 335 Backwell, L., d’Errico, F., 2008. Early hominid bone tools from Drimolen, South Africa.
336 Journal of Archaeological Science. 35, 2880–2894.
- 337 Backwell, L., d’Errico, F., 2015. Osseous Projectile Weaponry from Early to Late Middle
338 Stone Age Africa. In: Langley, M.C. (Ed.), Osseous Projectile Weaponry, Vertebrate
339 Paleobiology and Paleoanthropology. Springer Netherlands, Dordrecht, pp. 15–29.
- 340 Backwell, L., d’Errico, F., Wadley, L., 2008. Middle Stone Age bone tools from the
341 Howiesons Poort layers, Sibudu Cave, South Africa. Journal of Archaeological
342 Science. 35, 1566–1580.
- 343 Backwell, L.R., 2000. A critical assessment of southern African ‘early hominid bone tools.’
344 University of the Witwatersrand, Johannesburg.
- 345 Backwell, L.R., d’Errico, F., 2001. Evidence of termite foraging by Swartkrans early
346 hominids. Proceedings of the National Academy of Sciences. 98, 1358–1363.
- 347 Backwell, L.R., d’Errico, F., 2003. Additional evidence on the early hominid bone tools from
348 Swartkrans with reference to spatial distribution of lithic and organic artefacts. South
349 African Journal of Science. 99, 259–267.
- 350 Backwell, L.R., d’Errico, F., 2004. The first use of bone tools: a reappraisal of the evidence
351 from Olduvai Gorge, Tanzania. 64.

- 352 Backwell, L.R., Parkinson, A.H., Roberts, E.M., d’Errico, F., Huchet, J.-B., 2012. Criteria for
353 identifying bone modification by termites in the fossil record. *Palaeogeography,*
354 *Palaeoclimatology, Palaeoecology.* 337–338, 72–87.
- 355 Balter, V., Blichert-Toft, J., Braga, J., Telouk, P., Thackeray, F., Albarède, F., 2008. U–Pb
356 dating of fossil enamel from the Swartkrans Pleistocene hominid site, South Africa.
357 *Earth and Planetary Science Letters.* 267, 236–246.
- 358 Behrensmeyer, A.K., 1978. Taphonomic and Ecologic Information from Bone Weathering.
359 *Paleobiology.* 4, 150–162.
- 360 Behrensmeyer, A.K., Gordon, K.D., Yanagi, G.T., 1986. Trampling as a cause of bone
361 surface damage and pseudo-cutmarks. *Nature.* 319, 768–771.
- 362 Berger, L.R., de Ruiter, D.J., Steininger, C.M., Hancox, J., 2003. Preliminary results of
363 excavations at the newly investigated Coopers D deposit, Gauteng, South Africa.
364 *South African Journal of Science.* 99, 276–278.
- 365 Binford, L.R., 1978. *Nunamiut Ethnoarchaeology,* Academic Press. ed. New York.
- 366 Blumenschine, R.J., 1988. An experimental model of the timing of hominid and carnivore
367 influence on archaeological bone assemblages. *Journal of Archaeological Science.* 15,
368 483–502.
- 369 Blumenschine, R.J., Marean, C.W., Capaldo, S.D., 1996. Blind Tests of Inter-analyst
370 Correspondence and Accuracy in the Identification of Cut Marks, Percussion Marks,
371 and Carnivore Tooth Marks on Bone Surfaces. *Journal of Archaeological Science.* 23,
372 493–507.

- 373 Blumenschine, R.J., Selvaggio, M.M., 1988. Percussion marks on bone surfaces as a new
374 diagnostic of hominid behaviour. *Nature*. 333, 763–765.
- 375 Bountalis, A.C., Kuhn, B.F., 2014. Cave Usage by Multiple Taphonomic Agents: Issues
376 towards Interpreting the Fossil Bearing Cave Deposits in South Africa. *American*
377 *Journal of Zoological Research*. 2, 55–61.
- 378 Braga, J., Thackeray, J.F., Bruxelles, L., Dumoncel, J., Fourvel, J.-B., 2017. Stretching the
379 time span of hominin evolution at Kromdraai (Gauteng, South Africa): Recent
380 discoveries. *Comptes Rendus Palevol*. 16, 58–70.
- 381 Brain, C.K., 1967. Bone weathering and the problem of bone pseudo-tools. *South African*
382 *Journal of Science*. 63, 97–99.
- 383 Brain, C.K., 1980. Some criteria for the recognition of bone-collecting agencies in African
384 caves. In: *Fossils in the Making: Vertebrate Taphonomy and Paleoecology*.
385 Behrensmeyer, A. K. and Hill, A. P., Chicago, pp. 107–130.
- 386 Brain, C.K., 1981. *The Hunters or the Hunted? An Introduction to African Cave Taphonomy*.
387 University of Chicago Press, Chicago.
- 388 Brain, C.K., 1993. *Swartkrans. A Cave's Chronicle of Early Man*. Transvaal Museum,
389 Pretoria.
- 390 Brain, C.K., Churcher, C.S., Clark, J.D., Grine, F.E., Shipman, P., Susman, R.L., Turner, A.,
391 Watson, V., 1988. New evidence of early hominids, their culture and environment
392 from the Swartkrans cave, South Africa. *South African Journal of Science*. 84, 828–
393 835.

- 394 Brain, C.K., Shipman, P., 1993. The Swartkrans bone tools. In: Brain, C.K. (Ed.), Swartkrans:
395 A Cave's Chronicle of Early Man. Transvaal Museum Monograph, Pretoria, pp. 195–
396 215.
- 397 Brooks, A., Helgren, D., Cramer, J., Franklin, A., Hornyak, W., Keating, J., Klein, R., Rink,
398 W., Schwarcz, H., Smith, J., et al., 1995. Dating and context of three middle stone
399 age sites with bone points in the Upper Semliki Valley, Zaire. *Science*. 268, 548–553.
- 400 Brooks, A.S., Nevell, L., Yellen, J.E., Hartman, G., 2006. Projectile technologies of the MSA:
401 implications for modern human origins. In: Hovers, E., Kuhn, S.L. (Eds.), *Transitions*
402 *before the Transition: Evolution and Stability in the Middle Palaeolithic and Middle*
403 *Stone Age*. Springer, New York, pp. 233–255.
- 404 Bruxelles, L., Maire, R., Couzens, R., Thackeray, J.F., Braga, J., 2017. A revised stratigraphy
405 of Kromdraai. In: *Kromdraai, a Birthplace of *Paranthropus* in the Cradle of*
406 *Humankind*. Sun Media Metro, Johannesburg, pp. 31–48.
- 407 Caruana, M.V., 2017. Lithic Production Strategies in the Oldowan Assemblages from
408 Sterkfontein Member 5 and Swartkrans Member 1, Gauteng Province, South Africa.
409 *Journal of African Archaeology*. 15, 1–19.
- 410 Cruz-Uribe, K., 1991. Distinguishing Hyena from Hominid Bone Accumulations. *Journal of*
411 *Field Archaeology*. 18, 467.
- 412 d'Errico, F., Backwell, L., 2009. Assessing the function of early hominin bone tools. *Journal*
413 *of Archaeological Science*. 36, 1764–1773.

414 d'Errico, F., Backwell, L.R., 2003. Possible evidence of bone tool shaping by Swartkrans
415 early hominids. *Journal of Archaeological Science*. 30, 1559–1576.

416 d'Errico, F., Backwell, L.R., Berger, L.R., 2001. Bone tool use in termite foraging by early
417 hominids and its impact on our understanding of early hominid behaviour. *South
418 African Journal of Science*. 97, 71–75.

419 d'Errico, F., Backwell, L.R., Wadley, L., 2012. Identifying regional variability in Middle
420 Stone Age bone technology: The case of Sibudu Cave. *Journal of Archaeological
421 Science*. 39, 2479–2495.

422 d'Errico, F., Pitarch Martí, A., Shipton, C., Le Vraux, E., Ndiema, E., Goldstein, S., Petraglia,
423 M.D., Boivin, N., 2020. Trajectories of cultural innovation from the Middle to Later
424 Stone Age in Eastern Africa: Personal ornaments, bone artifacts, and ocher from
425 Panga ya Saidi, Kenya. *Journal of Human Evolution*. 141, 102737.

426 Dart, R.A., 1957. The osteodontokeratic culture of *Australopithecus prometheus*. *Transvaal
427 Museum Memoirs*. 1–105.

428 de Ruiter, D.J., Pickering, R., Steininger, C.M., Kramers, J.D., Hancox, P.J., Churchill, S.E.,
429 Berger, L.R., Backwell, L., 2009. New *Australopithecus robustus* fossils and
430 associated U-Pb dates from Cooper's Cave (Gauteng, South Africa). *Journal of
431 Human Evolution*. 56, 497–513.

432 Domínguez-Rodrigo, M., de Juana, S., Galán, A.B., Rodríguez, M., 2009. A new protocol to
433 differentiate trampling marks from butchery cut marks. *Journal of Archaeological
434 Science*. 36, 2643–2654.

435 Domínguez-Rodrigo, M., Pickering, T.R., Bunn, H.T., 2010. Configurational approach to
436 identifying the earliest hominin butchers. *Proceedings of the National Academy of*
437 *Sciences*. 107, 20929–20934.

438 Doyon, L., Zhanyang, L., Hua, W., Geis, L., d’Errico, F., 2020. A 115,000-year-old expedient
439 bone technology at Lingjing, Henan, China (preprint). *SocArXiv*.

440 El Hajraoui, A.M., Debénath, A., 2012. El Mnasra - Chapitre XXIV. L’industrie osseuse. In:
441 El Hajraoui, A.M., Nespoulet, R., Debénath, A., Dibble, H. (Eds.), *Préhistoire de La*
442 *Région de Rabat-Témara. Villes et Sites d’archéologie Marocaine, Royaume Du*
443 *Maroc. Ministère de la Culture et Institut National des Sciences de l’Archéologie et du*
444 *Patrimoine, Rabat*, pp. 179–188.

445 Fiorillo, A.R., 1989. An experimental study of trampling. In: Bonnichsen, R., and Sorg, M.
446 H., (Eds.), *Bone Modification. University of Maine*, pp. 61–98.

447 Fourvel, J.-B., 2012. Hyénidés modernes et fossiles d’Europe et d’Afrique : taphonomie
448 comparée de leurs assemblages osseux. *Université de Toulouse Le Mirail, Toulouse*.

449 Gibbon, R.J., Pickering, T.R., Sutton, M.B., Heaton, J.L., Kuman, K., Clarke, R.J., Brain,
450 C.K., Granger, D.E., 2014. Cosmogenic nuclide burial dating of hominin-bearing
451 Pleistocene cave deposits at Swartkrans, South Africa. *Quaternary Geochronology*. 24,
452 10–15.

453 Granger, D.E., Gibbon, R.J., Kuman, K., Clarke, R.J., Bruxelles, L., Caffee, M.W., 2015.
454 New cosmogenic burial ages for Sterkfontein Member 2 Australopithecus and
455 Member 5 Oldowan. *Nature*. 522, 85–88.

456 Hanon, R., 2019. Comportements de subsistance des hominines du Pléistocène inférieur
457 d’Afrique du Sud : analyse archéozoologique du site de Cooper’s D (Bloubank
458 Valley). Muséum National d’Histoire Naturelle, Paris.

459 Henshilwood, C.S., D’errico, F., Marean, C.W., Milo, R.G., Yates, R., 2001. An early bone
460 tool industry from the Middle Stone Age at Blombos Cave, South Africa: implications
461 for the origins of modern human behaviour, symbolism and language. *Journal of*
462 *Human Evolution*. 41, 631–678.

463 Herries, A.I.R., Curnoe, D., Adams, J.W., 2009. A multi-disciplinary seriation of early Homo
464 and Paranthropus bearing palaeocaves in southern Africa. *Quaternary International*.
465 202, 14–28.

466 Herries, A.I.R., Hopley, P.J., Adams, J.W., Curnoe, D., Maslin, M.A., 2010. Letter to the
467 editor: Geochronology and palaeoenvironments of Southern African hominin-bearing
468 localities-A reply to Wrangham et al., 2009. “Shallow-water habitats as sources of
469 fallback foods for hominins.” *American Journal of Physical Anthropology*. 143, 640–
470 646.

471 Herries, A.I.R., Martin, J.M., Leece, A.B., Adams, J.W., Boschian, G., Joannes-Boyau, R.,
472 Edwards, T.R., Mallett, T., Massey, J., Murszewski, A., Neubauer, S., Pickering, R.,
473 Strait, D.S., Armstrong, B.J., Baker, S., Caruana, M.V., Denham, T., Hellstrom, J.,
474 Moggi-Cecchi, J., Mokobane, S., Penzo-Kajewski, P., Rovinsky, D.S., Schwartz, G.T.,
475 Stammers, R.C., Wilson, C., Woodhead, J., Menter, C., 2020. Contemporaneity of
476 *Australopithecus* , *Paranthropus* , and early *Homo erectus* in South Africa. *Science*.
477 368, eaaw7293.

- 478 Herries, A.I.R., Shaw, J., 2011. Palaeomagnetic analysis of the Sterkfontein palaeocave
479 deposits: Implications for the age of the hominin fossils and stone tool industries.
480 *Journal of Human Evolution*. 60, 523–539.
- 481 Hill, A., 1987. Damage to some fossil bones from Laetoli. In: Leakey, M. D., and Harris, J.
482 M., (Eds.), *Laetoli. A Pliocene Site in Northern Tanzania*. Oxford, pp. 543–544.
- 483 Huchet, J.-B., 2014. Approche ichnologique et taphonomique des altérations ostéolytiques
484 dues aux insectes en contexte archéologique. In: Denys, C., and Patou-Mathis, M.,
485 (Eds.), *Manuel de Taphonomie, Collection “Archéologiques.”* Errance, Muséum
486 National d’Histoire Naturelle and CNRS, Paris, pp. 185–207.
- 487 Kaiser, T.M., 2000. Proposed Fossil Insect Modification to Fossil Mammalian Bone from
488 Plio-Pleistocene Hominid-Bearing Deposits of Laetoli (Northern Tanzania). *Annals of*
489 *the Entomological Society of America*. 93, 693–700.
- 490 Keyser, A.W., Menter, C.G., Moggi-Cecchi, J., Pickering, T.R., Berger, L.R., 2000.
491 *Drimolen: a new hominid-bearing site in Gauteng, South Africa*. *South African*
492 *Journal of Science*. 96, 193–197.
- 493 Kuhn, B.F., Berger, L.R., Skinner, J.D., 2010. Examining criteria for identifying and
494 differentiating fossil faunal assemblages accumulated by hyenas and hominins using
495 extant hyenid accumulations. *International Journal of Osteoarchaeology*. 15–35.
- 496 Kuman, K., 2007. The earlier Stone Age in South Africa: site context and the influence of
497 cave studies. In: Pickering, T. R., Schick, K., and Toth, N., (Eds.), *Breathing Life Into*
498 *Fossils: Taphonomic Studies in Honor of C. K. (Bob) Brain*. Gosport, pp. 181–198.

- 499 Kuman, K., Clarke, R.J., 2000. Stratigraphy, artefact industries and hominid associations for
500 Sterkfontein, Member 5. *Journal of Human Evolution*. 38, 827–847.
- 501 Lyman, R.L., 1994. *Vertebrate Taphonomy*, Cambridge University Press. ed, Cambridge
502 manuals in archaeology. Cambridge.
- 503 Maguire, J.M., Pemberton, D., Collett, M.H., 1980. The Makapansgat limeworks gray
504 breccia: hominids, hyaenas, hystricids or hill wash. *Palaeontologia africana*. 23, 75–
505 98.
- 506 Moggi-Cecchi, J., Menter, C., Boccone, S., Keyser, A., 2010. Early hominin dental remains
507 from the Plio-Pleistocene site of Drimolen, South Africa. *Journal of Human Evolution*.
508 58, 374–405.
- 509 Olsen, S.L., Shipman, P., 1988. Surface modification on bone: Trampling versus butchery.
510 *Journal of Archaeological Science*. 15, 535–553.
- 511 Pante, M., Torre, I. de la, d’Errico, F., Njau, J., Blumenschine, R., 2020. Bone tools from
512 Beds II–IV, Olduvai Gorge, Tanzania, and implications for the origins and evolution
513 of bone technology. *Journal of Human Evolution*. 148, 102885.
- 514 Parkinson, A.H., 2016. Traces of Insect Activity at Cooper’s D Fossil Site (Cradle of
515 Humankind, South Africa). *Ichnos*. 23, 322–339.
- 516 Patou-Mathis, M., 1997. Les marques de boucherie au Paléolithique. *Revue Médical*
517 *Vétérinaire*. 148, 959–968.
- 518 Pickering, R., Herries, A.I.R., Woodhead, J.D., Hellstrom, J.C., Green, H.E., Paul, B.,
519 Ritzman, T., Strait, D.S., Schoville, B.J., Hancox, P.J., 2019. U–Pb-dated flowstones

520 restrict South African early hominin record to dry climate phases. *Nature*. 565, 226–
521 229.

522 Pickering, R., Kramers, J.D., 2010. Re-appraisal of the stratigraphy and determination of new
523 U-Pb dates for the Sterkfontein hominin site, South Africa. *Journal of Human*
524 *Evolution*. 59, 70–86.

525 Pickering, T.R., 2002. Reconsideration of criteria for differentiating faunal assemblages
526 accumulated by hyenas and hominids. *International Journal of Osteoarchaeology*. 12,
527 127–141.

528 Porraz, G., E., P.J., Schmidt, P., Gérald, B., Jean-Philippe, B., Laure, D., Marina, I., Miller,
529 C.E., Schmid, V.C., Chantal, T., Aurore, V., Christine, V., Pierre-Jean, T., 2020.
530 Experimentation preceding innovation in a MIS5 Pre-Still Bay layer from Diepkloof
531 Rock Shelter (South Africa): emerging technologies and symbols (preprint).
532 *EcoEvoRxiv*.

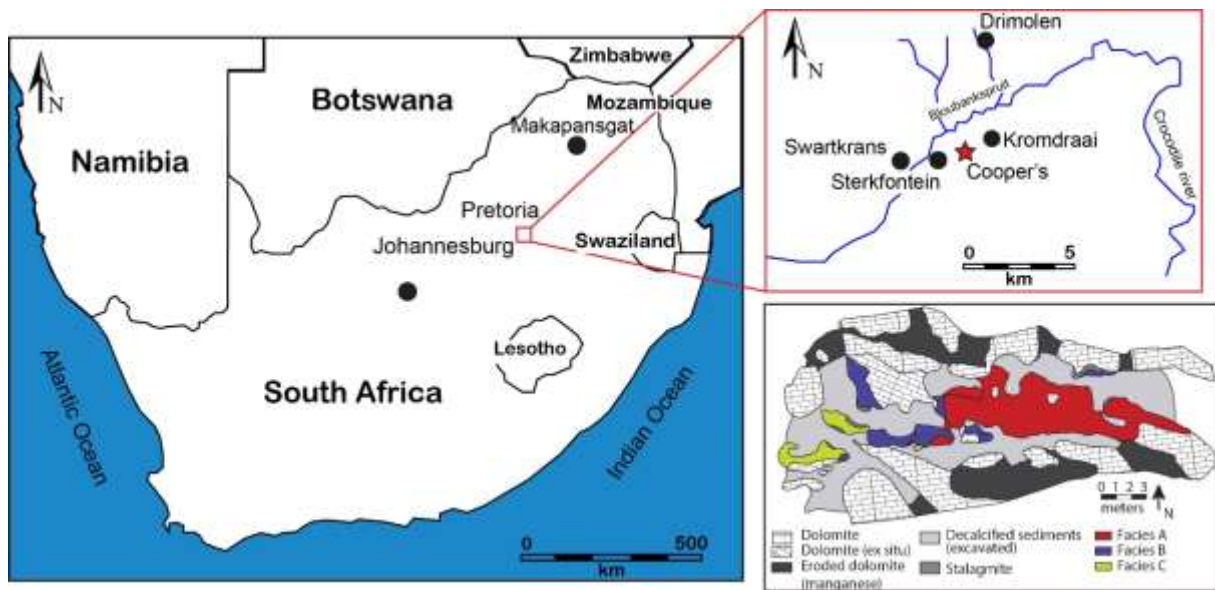
533 Potts, R., Shipman, P., 1981. Cutmarks made by stone tools on bones from Olduvai Gorge,
534 Tanzania. *Nature*. 291, 577–580.

535 Robinson, J.T., 1959. A Bone Implement from Sterkfontein. *Nature*. 184, 583–585.

536 Shipman, P., Rose, J., 1983. Early hominid hunting, butchering, and carcass-processing
537 behaviors: Approaches to the fossil record. *Journal of Anthropological Archaeology*.
538 2, 57–98.

- 539 Stammers, R.C., Caruana, M.V., Herries, A.I.R., 2018. The first bone tools from Kromdraai
540 and stone tools from Drimolen, and the place of bone tools in the South African
541 Earlier Stone Age. *Quaternary International*. 495, 87–101.
- 542 Steininger, C., Berger, L.R., Kuhn, B.F., 2008. A partial skull of *Paranthropus robustus* from
543 Cooper's Cave, South Africa. *South African Journal of Science*. 104, 143–146.
- 544 Sutton, M.B., Kuman, K., Steininger, C., 2017. Early Pleistocene stone artefacts from
545 Cooper's cave, South Africa. *South African Archaeological Bulletin*. 72, 156–161.
- 546 Val, A., Stratford, D.J., 2015. The macrovertebrate fossil assemblage from the Name
547 Chamber, Sterkfontein: taxonomy, taphonomy and implications for site formation
548 processes. *Palaeontologia Africana*. 50, 49–58.
- 549 Val, A., Taru, P., Steininger, C., 2014. New taphonomic analysis of large-bodied primate
550 assemblage from Cooper's D, Bloubank Valley, South Africa. *South African
551 Archaeological Bulletin*. 69, 49–58.
- 552 Villa, P., Mahieu, E., 1991. Breakage patterns of human long bones. *Journal of Human
553 Evolution*. 21, 27–48.
- 554 Yellen, J., Brooks, A., Cornelissen, E., Mehlman, M., Stewart, K., 1995. A middle stone age
555 worked bone industry from Katanda, Upper Semliki Valley, Zaire. *Science*. 268, 553–
556 556.
- 557 Zutovski, K., Barkai, R., 2016. The use of elephant bones for making Acheulian handaxes: A
558 fresh look at old bones. *Quaternary International*. 406, 227–238.

559

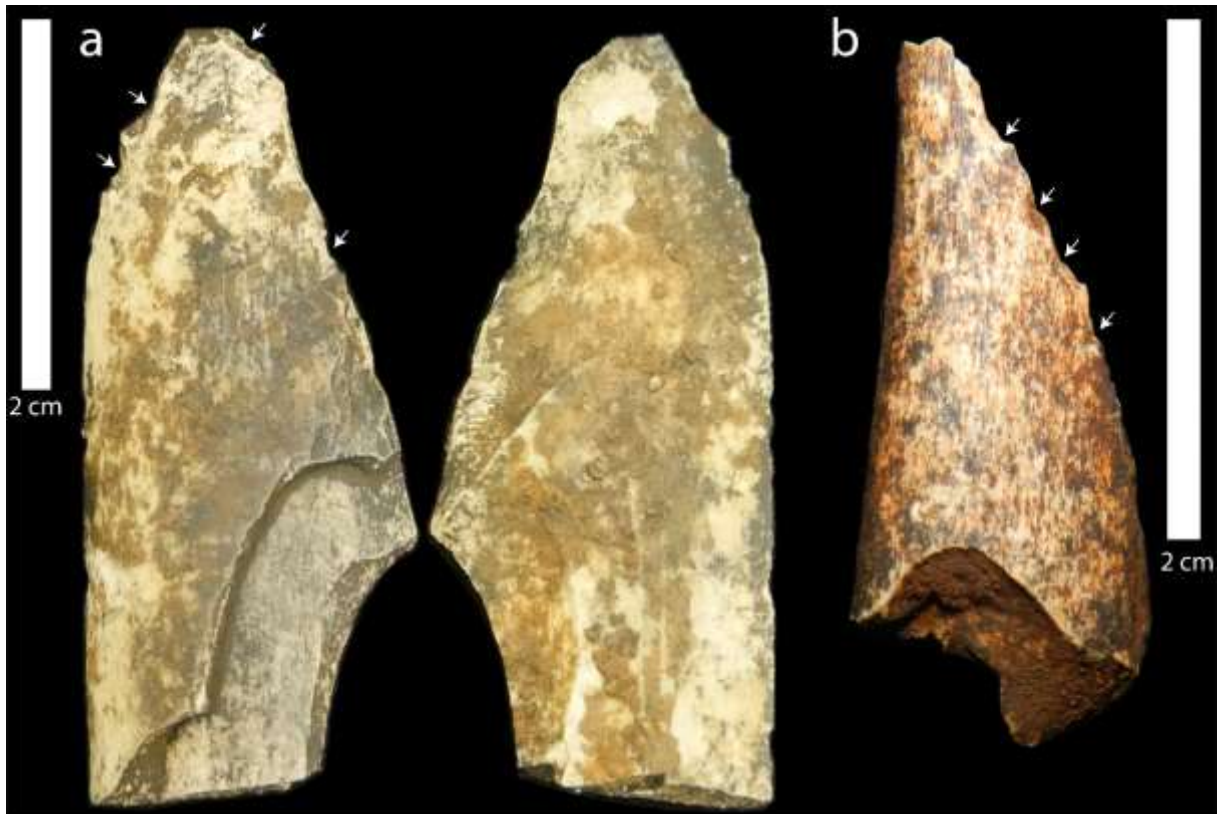


560

561 **Figure 1:** Locality of Cooper's Cave and other Early Stone Age-bearing bone tool sites in South
562 Africa with a geological plan of the Cooper's D site (modified after de Ruiter et al., 2009).

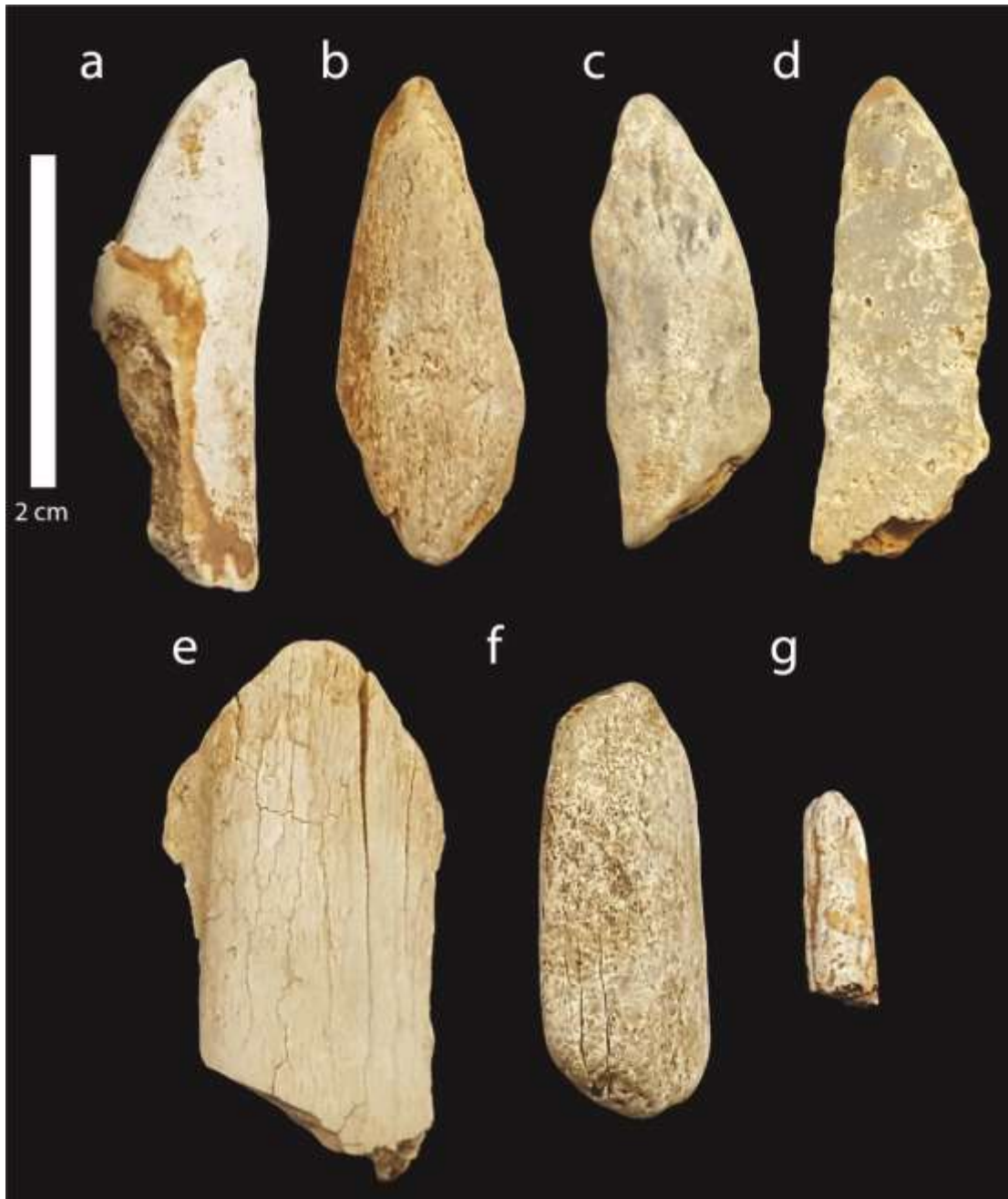
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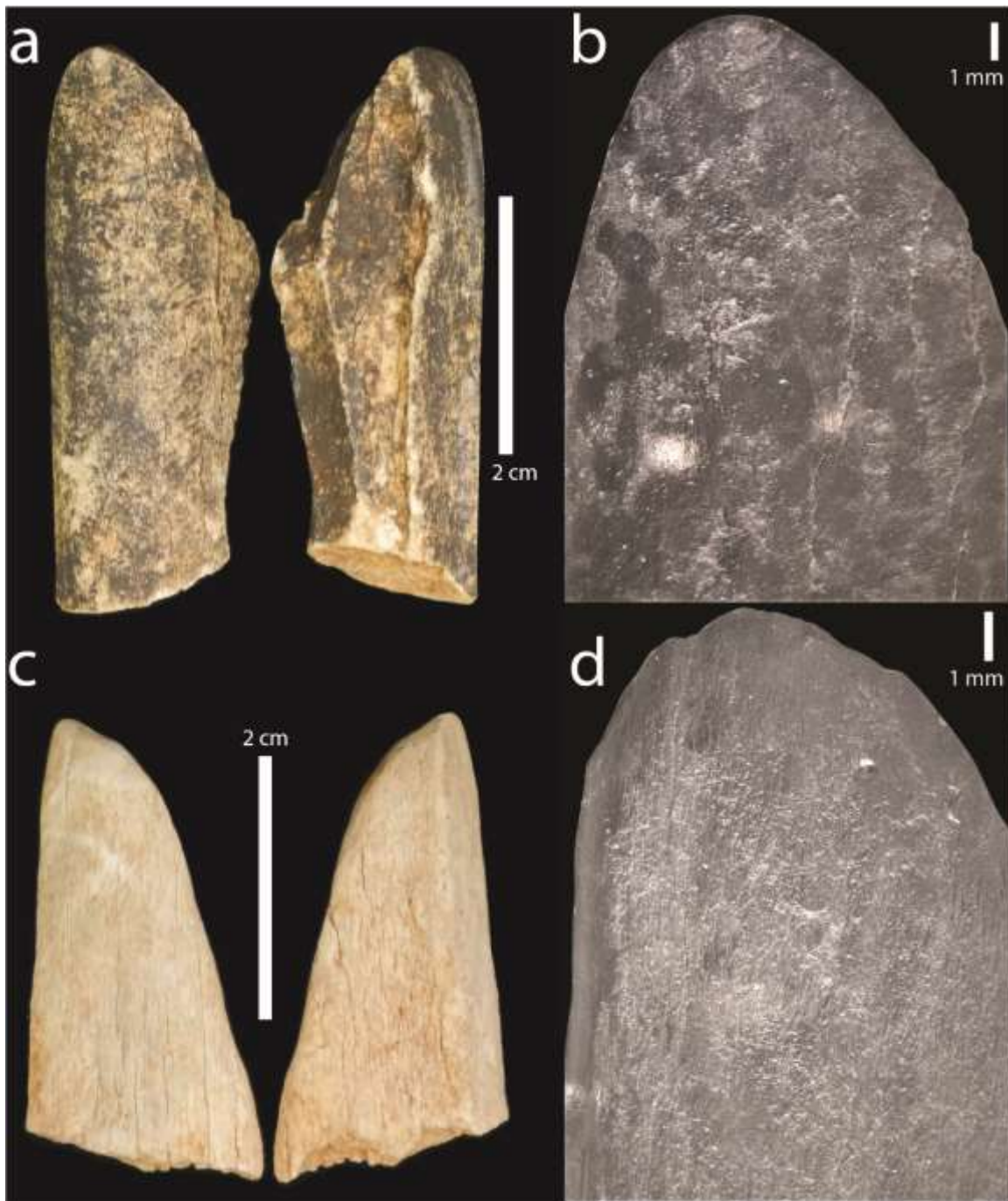
566 **Figure 2:** Photographs of specimens CD.9977 (a) and CD.3046C (b) displaying denticulated
567 micro flake scars along their edges (arrows). Scales = 2 cm.



568

569 **Figure 3:** Rounded bone fragments from Cooper's D interpreted as pseudo-tools; CD.1649 (a),
570 CD.7900 (b), CD.15631 (c), CD.3538 (d), CD.3529 (e), CD.3528 (f), CD.343 (g). Scale = 2
571 cm.

572



573

574 **Figure 4:** Photographs of bone fragments from Cooper's D interpreted as pseudo-tools,
575 CD.6978A (a) and CD.1293 (c) and photographs of their rounded tips taken in transmitted light
576 on resin replicas CD.6978A (b) and CD.1293 (d). Scales = 2 cm (a, c) and 1 mm (b, d).

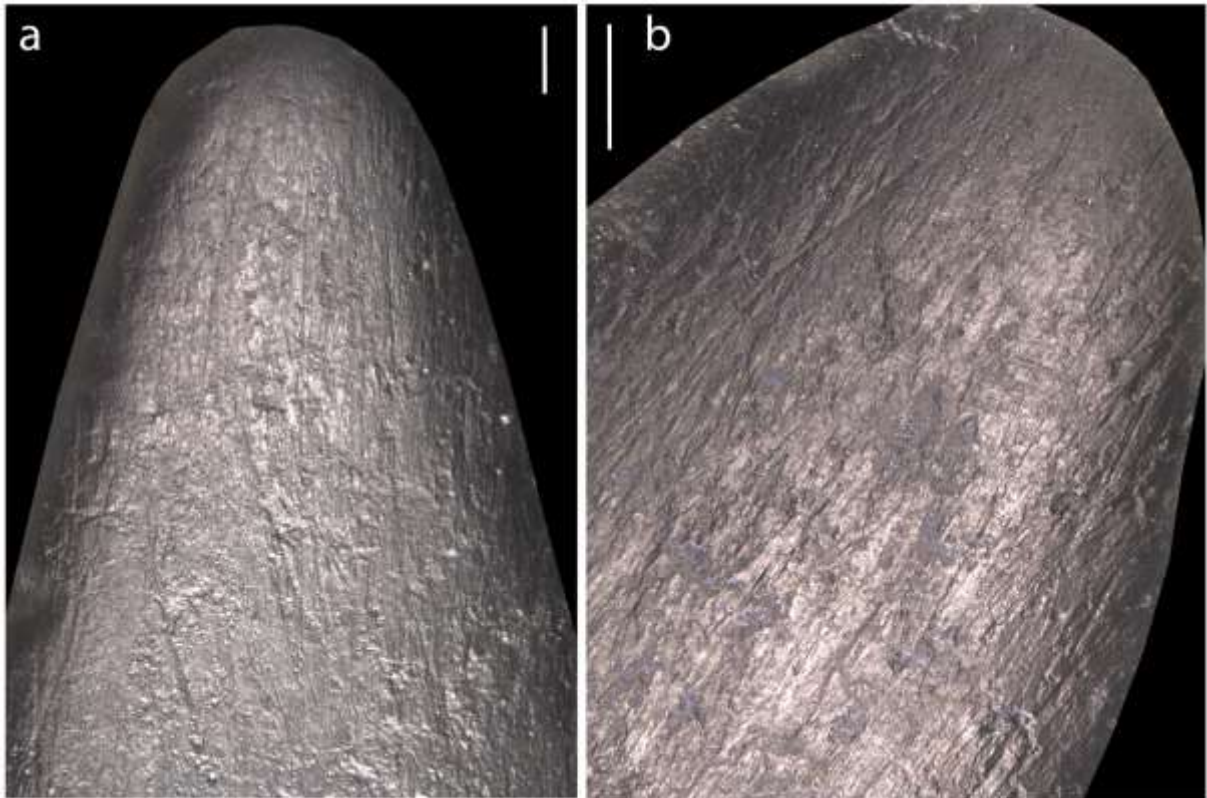
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579 **Figure 5:** Photographs of the bone tool from Cooper's D (CD.7895) showing the cortical (left)
580 and medullary (right) surfaces. Scale = 2cm.

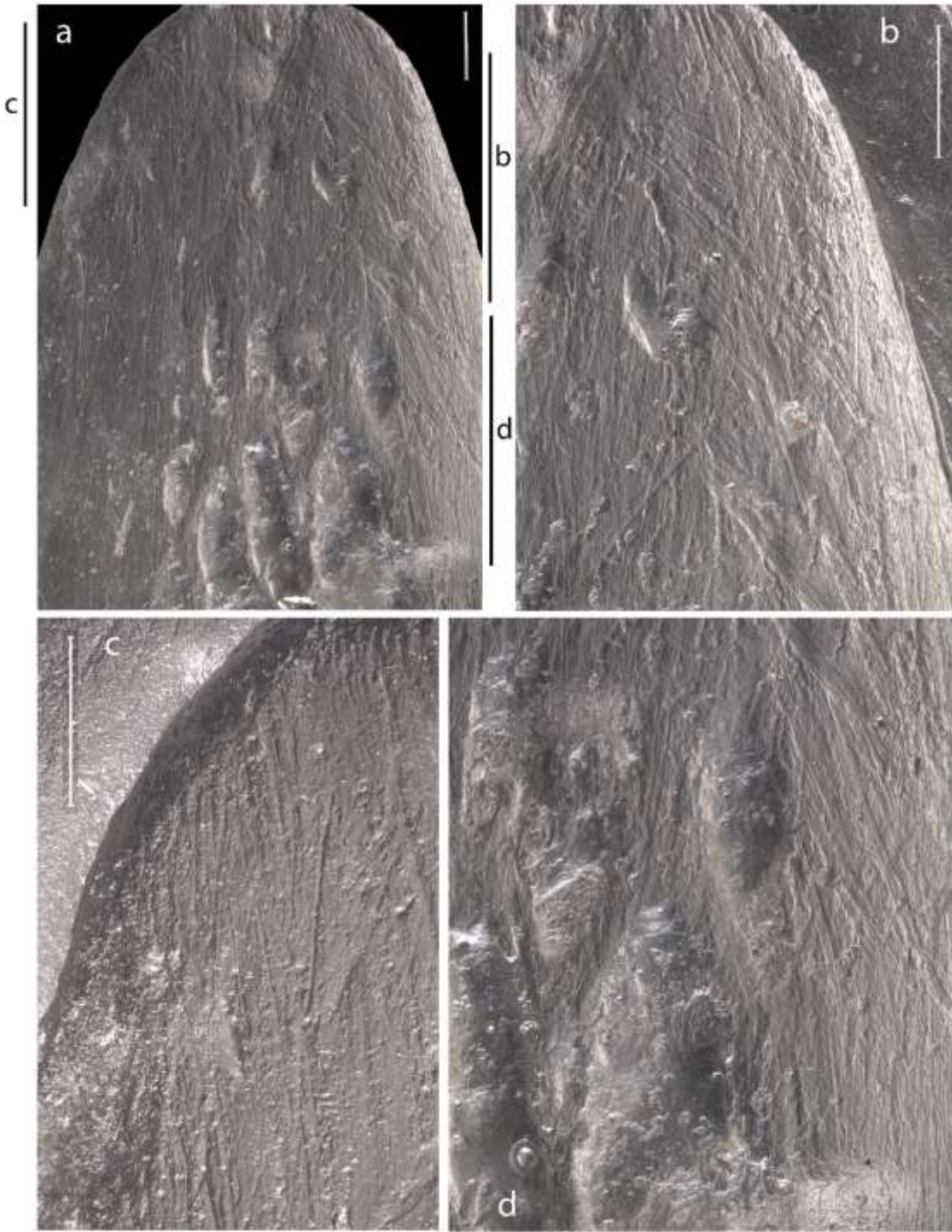
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583 Figure 6: Periosteal surface of the bone tool tip from Cooper's D (CD.7895) showing
584 characteristic longitudinal subparallel, intersecting striations. Photographs taken in transmitted
585 light on resin replicas. Scales = 1 mm.

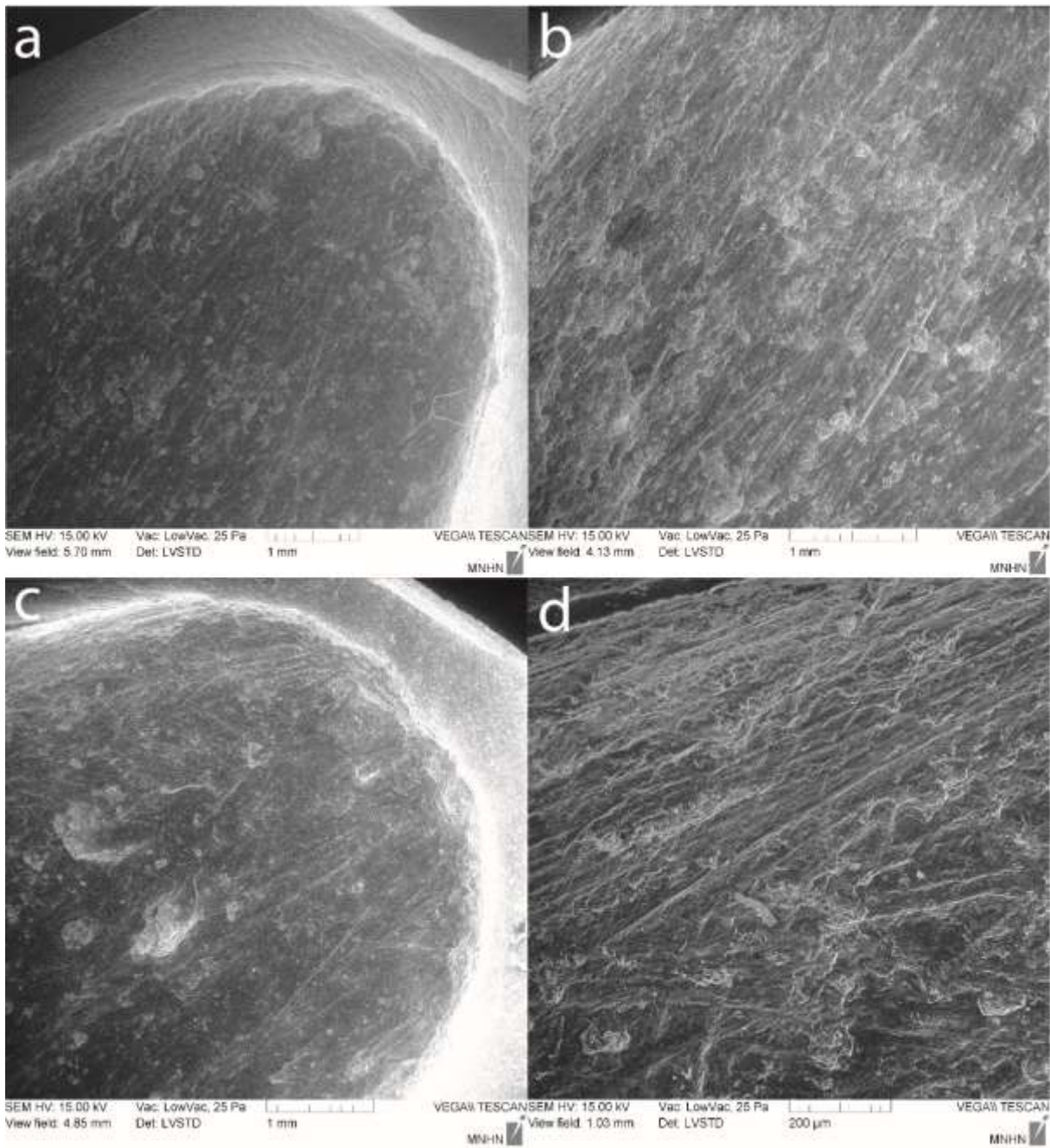
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588 **Figure 7:** Medullary surface (a) of the bone tool from Cooper's D (CD.7895) and close-up
589 views of the tip (b-c) and right side of the object. Notice the myriad number of individual
590 intersecting lines flattening the bone surface and only sparing concave areas of trabecular bone.
591 Scales = 1 mm.

592



593

594 **Figure 8:** Scanning electron micrographs of the Cooper's D bone tool tip (CD.7895) (top and
 595 bottom left) and close-up views (right) showing microstriations produced by the use of the tool.
 596 Scales = 1 mm (a-c) and 200 μm (d).

597

598