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## Natural mummies from Predynastic Egypt reveal the world's earliest figural tattoos

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1 **Natural mummies from Predynastic Egypt reveal the world's earliest figural**  
2 **tattoos**

3  
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14  
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25 **Keywords:** tattoos; natural mummies; radiocarbon dating; Egyptian Predynastic art;  
26 infrared imaging; isotopic analysis.

27  
28  
29 **Abstract**

30  
31 The application of tattoos to the human body has enjoyed a long and diverse history  
32 in many ancient cultures. At present, the oldest surviving examples are the mainly  
33 geometric tattoos on the individual known as Ötzi, dating to the late 4th millennium  
34 BCE, whose skin was preserved by the ice of the Tyrolean Alps. In the Egyptian Nile  
35 valley, the arid climate has also promoted extensive soft tissue preservation. Here  
36 we report on the tattoos found during the examination of two of the best preserved  
37 naturally mummified bodies from Egypt's Predynastic (c. 4000-3100 BCE) period,  
38 making them the earliest extant examples from the Nile Valley. Figural tattoos that  
39 mirror motifs found in Predynastic art were observed on the right arm of one male  
40 and the right arm and shoulder of one female, demonstrating conclusively that  
41 tattooing was practiced in prehistoric Egypt. These findings overturn the  
42 circumstantial evidence of the artistic record that previously suggested only females  
43 were tattooed for fertility or even erotic reasons. Radiocarbon testing and datable  
44 iconographic parallels for the motifs indicate that these tattooed individuals are  
45 nearly contemporaneous with the Iceman, positioning them amongst the bearers of  
46 some of the oldest preserved tattoos in the world. At over five thousand years of age,  
47 they push back the evidence for tattooing in Africa by a millennium and provide new  
48 insights into the range of potential uses of tattoos in pre-literate societies by both  
49 sexes, revealing new contexts for exploring the visual language of prehistoric times.

## 51 **1. Introduction**

52

53 Interpretations of the artistic record and certain tool assemblages suggest the  
54 application of tattoos to the human body has enjoyed a long and diverse history in  
55 many cultures, perhaps going back to the Palaeolithic (Deter-Wolf, 2013; Deter-Wolf  
56 and Peres, 2013; Deter-Wolf et al., 2016). Absolute proof of this practice depends on  
57 the survival of human skin. The British Museum curates seven well-preserved  
58 examples of naturally mummified individuals from Egypt's Predynastic period  
59 (Dawson and Gray, 1968), the era preceding the country's unification by the first  
60 pharaoh at around 3100 BCE. All visible skin on these mummified individuals was  
61 examined for signs of body modification as part of a new program of conservation  
62 and research. Tattoos were discovered on two of the seven mummies: one male (EA  
63 32751) and one female (EA 32752). Originally buried in shallow graves, their bodies  
64 were naturally desiccated by the heat, salinity and aridity of the Egyptian desert. The  
65 bodies show none of the signs of the deliberate and invasive embalming that define  
66 later Egyptian funerary traditions, although some form of external treatment cannot  
67 be excluded (Jones et al., 2014). In addition to extensive skin and muscle survival,  
68 CT scans have revealed the remarkable preservation of the internal organs (Antoine  
69 and Ambers, 2014; Taylor and Antoine, 2014). All seven individuals are reported to  
70 come from the site of Gebelein located in the southern part of Upper Egypt, but little  
71 else is known of their burial context, identity or status. Six of them (EA 32751-32756)  
72 were obtained for the museum in 1899 by Sir E.A. Wallis Budge, who claimed to  
73 have been present at their excavation (Budge, 1920). The seventh body (EA 57353)  
74 was purchased subsequently at auction from the collection of de Rustafjaell (Dawson  
75 and Gray, 1968; de Rustafjaell 1909). Although the veracity of Budge's account has  
76 been questioned, his description of the grave goods and burial setting, as well as the  
77 flexed position of the bodies and still surviving remnants of animal hide, matting and  
78 linen covering them, are all typical attributes of the Predynastic burial tradition. The  
79 radiocarbon results, supported by isotopic data, on hair and bone collagen sampled  
80 from six of the bodies for this study (see below) now confirm this attribution, with  
81 collective dates ranging from 3932 to 3030 cal BC (68.2% probability).

82

## 83 **2. Materials and methods**

84

### 85 *2.1 Infrared imaging and the Gebelein mummies*

86

87 As part of an on-going programme of reanalysis and conservation, the skin of each  
88 Predynastic natural mummy was examined using infrared imaging under both flash  
89 and ambient light conditions with a hand-held Panasonic Lumix DMC ZS19 camera,  
90 converted to 720nm infrared by Kolari Vision. Tattoos were detected on the  
91 observable areas of the bodies of two individuals: EA32751, a male known as  
92 Gebelein Man A and currently on display in The British Museum's Early Egypt  
93 Gallery (Room 64), and EA32752, a female known as Gebelein Woman.

94

95 Remnants of the animal hide, matting and linen used to cover the bodies of these  
96 individuals are present but most of these wrappings were removed prior to their  
97 arrival at the Museum, most probably during excavation. The accessible skin on  
98 each individual was systematically photographed with the infrared camera in a series  
99 of overlapping views. The tattoos appeared distinctly as dark forms against the  
100 lighter areas of the skin, requiring no image manipulation. Given the fragile nature of

101 the remains, the examination of each mummy was restricted to the areas easily  
102 accessible and most could not be lifted to examine the side on which they are  
103 resting. Bar one, these individuals had been buried in a crouched position on their  
104 left sides and stored in that position, so that generally only the right side of the body  
105 and full back was visible, although in some cases obscured by remnants of the  
106 original covering of hide, textile or matting, or hindered by poor skin preservation.  
107 The areas available for examination are summarized in Table 1. Only Gebelein  
108 Woman (EA32752) was robust enough to be examined on all sides. The limited  
109 access coupled with variable skin preservation leaves open the possibility that more  
110 tattoos were originally present and that others may be found on these individuals in  
111 the future.

112

113

PLEASE ADD TABLE ONE HERE

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115

116 The preserved skin of the tattooed mummies was meticulously cleaned by  
117 experienced conservators. The designs are not superficial and appear to have been  
118 applied into the dermis layer of the skin. The strong signature of the tattoos detected  
119 by the infrared camera indicates the pigment was predominantly carbon-based,  
120 presumably some sort of soot (see Poon, 2008). No testing of the pigments has yet  
121 been undertaken to determine its composition (see for example Pabst et al., 2009,  
122 2010). The sex of the tattooed mummies was confirmed by CT scan. Three-  
123 dimensional images of the pelvis were scored using the dimorphic traits  
124 recommended in Buikstra and Ubelaker (1994) and Bruzek (2002). The scan also  
125 revealed that the male tattooed mummy's skeleton (EA 32751) was in the process of  
126 completing its growth and, based on the developmental data published in Scheuer  
127 and Black (2000), he was approximately 18-21 years old when he died (Antoine and  
128 Ambers, 2014).

129

## 130 *2.2 Radiocarbon and isotope analyses*

131

132 Both of the tattooed mummies (EA 32751 and EA 32752) are very well-preserved  
133 with little or no access to the skeleton. A small amount of bone recovered from the  
134 exposed skull of EA 32752 did not yield datable extracts (see below), and no bone  
135 could be sampled from EA 32751. To avoid damaging the body tissues, hairs were  
136 carefully removed from the heads and used for the radiocarbon analysis. The  
137 samples were pretreated at the <sup>14</sup>CHRONO Centre to remove potential  
138 contamination with a three step solvent extraction in a soxhlet distillation apparatus  
139 using first chloroform and methanol (2:1), then ethanol, and lastly water (Bruhn et al.,  
140 2001). In addition to the hair, two samples each of two standards (IAEA-C3 and TIRI  
141 B) were pretreated using the same method to ensure that there was no possibility of  
142 either ancient or modern carbon contamination from the solvent treatment. The  
143 samples were dried in an oven at 60°C overnight, weighed into pre-combusted  
144 quartz tubes with an excess of copper oxide (CuO), sealed under vacuum and  
145 combusted to carbon dioxide (CO<sub>2</sub>). The CO<sub>2</sub> was converted to graphite on an iron  
146 catalyst using the zinc reduction method (Slota et al., 1987). The <sup>14</sup>C/<sup>12</sup>C and <sup>13</sup>C/<sup>12</sup>C  
147 ratios were measured by accelerator mass spectrometry (AMS). The sample <sup>14</sup>C/<sup>12</sup>C  
148 ratio was background corrected and normalised to the HOXII standard (SRM 4990C;  
149 National Institute of Standards and Technology). The radiocarbon ages were  
150 corrected for isotope fractionation using the AMS measured <sup>13</sup>C/<sup>12</sup>C ratio which

151 accounts for both natural and machine fractionation. The radiocarbon age and one  
152 standard deviation were calculated using the Libby half-life of 5568 years, following  
153 the methods of Stuiver and Polach (1977). No contamination from the solvent  
154 extraction was detected in either the modern IAEA-C3 or the circa one half-life TIRI  
155 B standards.

156  
157 The other Gebelein mummies curated at the British Museum are not as extensively  
158 preserved and skeletal material could be obtained for radiocarbon dating. Bone  
159 collagen samples were successfully extracted at the Max Planck Institute for  
160 Evolutionary Anthropology (MPI-EVA; Leipzig, Germany) from non-tattooed Gebelein  
161 mummies for the radiocarbon and the isotopic analysis, following the pretreatment  
162 protocol based on Talamo and Richards (2011). In order to monitor contamination  
163 introduced during the pre-treatment stage, collagen from a cave bear bone kindly  
164 provided by D. Döppes (Klaus-Tschira AMS facility, Germany) was extracted with  
165 each batch of samples as a background. Elemental and stable isotopic data  
166 (percentage carbon and nitrogen content, carbon to nitrogen ratio,  $\delta^{13}\text{C}$  and  $\delta^{15}\text{N}$ ) of  
167 extracted collagen were measured in-house at the MPI-EVA, and approximately 5 to  
168 6 mg weighed into pre-cleaned tin cups at the MPI-EVA and sent to the Klaus-  
169 Tschira-AMS facility (lab code: MAMS). Samples were combusted in an Elemental  
170 Analyser and  $\text{CO}_2$  converted catalytically to graphite and dated using the MICADAS-  
171 AMS (Kromer et al., 2013). The isotopic values were measured at MPI-EVA on a  
172 ThermoFinnigan Delta V Advantage isotope ratio mass spectrometer (IRMS)  
173 coupled to a Flash 2000 EA. Stable carbon isotope ratios are expressed relative to  
174 VPDB (Vienna PeeDee Belemnite) and stable nitrogen isotope ratios were measured  
175 relative to AIR [atmospheric  $\text{N}_2$  with an analytical error of 0.2 ‰ ( $1\sigma$ ) for  $\delta^{13}\text{C}$  and  
176  $\delta^{15}\text{N}$ ]. In addition, stable isotopes ( $\delta^{13}\text{C}$  and  $\delta^{15}\text{N}$ ) and carbon to nitrogen ratios were  
177 measured on the pretreated hair samples from the tattooed mummies at the  
178  $^{14}\text{C}$ CHRONO Centre using a Thermo Delta V elemental analyser - isotope ratio mass  
179 spectrometer (EA-IRMS).

180

### 181 **3. Results**

182

#### 183 *3.1 Dating*

184

185 Radiocarbon dating on hair from the two tattooed mummies, and on bone collagen  
186 from four other mummies from Gebelein (Table 2), produced an age range  
187 consistent with Egypt's Predynastic period (c. 4000-3100 BCE). The hair sample  
188 from the tattooed female produced a radiocarbon age of  $4497 \pm 32$   $^{14}\text{C}$  BP (UBA-  
189 33754), calibrated using IntCal13 in the OxCal 4.2 program (Ramsey, 2009; Reimer  
190 et al., 2013) to 3351-3092 cal BC ( $2\sigma$ , 95.4% probability) and to 3334-3104 cal BC  
191 ( $1\sigma$ , 68.2% probability). The sample from the male tattooed mummy produced a  
192 radiocarbon age of  $4461 \pm 36$   $^{14}\text{C}$  BP (UBA-33753), calibrated to 3341-3017 cal BC  
193 ( $2\sigma$ ) and to 3327-3030 cal BC ( $1\sigma$ ). The results from both of the tattooed individuals  
194 correspond to the generally accepted dates for the latter part of the Predynastic  
195 period (Naqada IID-IIIB, see Hendrickx, 2006; Patch, 2011; Tassie, 2014).

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### 202 3.2 *The tattoos*

203

204 The male mummy (EA32751), known as Gebelein Man A, has been on display  
205 almost continuously since his discovery over 100 years ago, yet the indistinct dark  
206 smudges on his upper right arm raised little interest and remained unexamined.  
207 Appearing as faint markings under natural lighting condition, the tattoos can now be  
208 distinguished under infrared imaging as depicting two horned animals facing toward  
209 the front of the body (Fig. 1). The two images, one somewhat lighter line weight than  
210 the other, overlap slightly, with one placed below and in front of the other, possibly  
211 suggesting they were applied at different times. No other tattoos were found on the  
212 parts of the body currently visible.

213

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218 **Fig. 1.** Tattoos on the Predynastic male mummy from Gebelein. Top: Infrared image  
219 of the male mummy known as Gebelein Man A (EA 32751). Lower left: Detail of the  
220 tattoos observed on his right arm under infrared light. Lower right: The mummy and  
221 tattoos under normal lighting conditions. Images courtesy of the Trustees of The  
222 British Museum.

223

224

225 Infrared examination of the female mummy (EA 32752), known as Gebelein Woman,  
226 revealed several tattoos (Fig. 2). A series of four small 'S' shaped motifs can be seen  
227 running vertically over the superior aspect of her right shoulder, crossing the joint  
228 between the humerus and scapula. Below them, on the lateral aspect of the upper  
229 right arm, is a linear motif that bends nearly 90 degrees toward the anterior of the  
230 body and has short perpendicular strokes at its extremities. Under natural lighting  
231 conditions the tattoos appear as vague greenish markings on the skin. An irregular  
232 dark line also runs horizontally across the lower abdomen, close to the level of the  
233 navel, but its origins and extent are impossible to ascertain at this time due to the  
234 tightly contracted position of the legs. No other tattoos or markings were found  
235 elsewhere on her body including the left side, which was also examined.

236

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PLEASE ADD FIGURE TWO HERE

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241 **Fig. 2.** Tattoos on the Predynastic female mummy from Gebelein. Infrared images of  
242 the mummy (EA 32752), with details of the tattoos observed on her upper right arm  
243 (upper left) and shoulder (upper right). An irregular dark line also runs horizontally  
244 across the lower abdomen (bottom). Images courtesy of the Trustees of The British  
245 Museum.

246

247

### 248 3.3 *Isotope analyses and quality controls*

249

250 Our research aimed to obtain absolute dates for each individual and, as part of this  
251 work, isotope analyses were conducted to ensure quality control and provide dietary  
252 insights that might reveal other distinct attributes of the tattooed individuals. Initially,  
253 bulk bone collagen samples (represented by eight samples) were to be used, but  
254 only two individuals (i.e. EA 32752 and EA 57353; Table 3) yielded extracts that fully  
255 match the quality criteria proposed by van Klinken (1999). The extract from EA  
256 32755 has percentage yield, elemental and isotopic values compatible with well-  
257 preserved collagen, but its atomic carbon to nitrogen ratio is just above the accepted  
258 range. The collagen data from these individuals are valid for palaeodietary  
259 reconstructions but the bone sample from EA 32752 (the female tattooed mummy)  
260 had a rather low yield (0.6%) and the extract was not sufficient for AMS radiocarbon  
261 dating (2.3 mg), which was only undertaken on the bone collagen of EA 32753, EA  
262 32755, EA 32756 and EA 57353. Three well-preserved samples (EA 32753, EA  
263 32755 and EA 57353) have  $\delta^{13}\text{C}$  values ranging from -20.0‰ to -18.3‰ (mean  $\delta^{13}\text{C}$ :  
264  $-19.1 \pm 0.9$  ‰) and  $\delta^{15}\text{N}$  values ranging from 13.3‰ to 14.9‰ (mean  $\delta^{15}\text{N}$ :  
265  $14.0 \pm 0.8$  ‰). Overall, the carbon isotope values fall within the variability for terrestrial  
266 environments dominated by  $\text{C}_3$  plants. The sample from EA 57353 has a high  $\delta^{13}\text{C}$   
267 value (= -18.3‰) for a pure  $\text{C}_3$  environment and it is, thus, possible that some of this  
268 individual's diet originated in a small proportion either from  $\text{C}_4$  plants or from the  
269 protein of animals that fed on such plants.

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271

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275 The carbon isotope value of EA 57353 also differs from the Gebelein skeletal  
276 remains analyzed by Iacumin et al. (1996; see discussion below). As this mummy  
277 was acquired at auction a decade after the other six, this raises the possibility that its  
278 reported provenance may not be correct. The two tattooed individuals (EA 32751  
279 and EA 32752) have almost identical isotopic compositions as the other Gebelein  
280 mummies in the British Museum collection (in particular to EA 32753 and EA 32755,  
281 although their extracts fall just outside the quality criteria proposed by van Klinken,  
282 1999).

283

284

## 285 4. Discussion

286

### 287 4.1 The tattoos

288

289 The horned animals found on Gebelein Man A are frequent elements in early  
290 Egyptian iconography but identifying the species intended remains a challenge  
291 (Graff, 2009). Based on the shape of its elaborate horns, as well as the long tail, the  
292 lower tattoo represents a bovid, most probably wild cattle (*Bos primigenius*). The  
293 downward curving horns and the humped shoulder of the upper tattoo suggest it is a  
294 Barbary sheep (*Ammotragus lervia*). Both animals are well-known in Predynastic art  
295 but the closest stylistic parallels are found among incised potmarks, carved ivories  
296 and decorated palettes (Fig. 3; Patch, 2011; Petrie, 1896) of the late and terminal  
297 phases of the period (Naqada IID-III A, conventionally situated at c. 3400-3200 BCE;  
298 see below), as well as in more difficult to date rock art (Hendrickx et al., 2009; Judd,  
299 2009). While the significance of the Barbary sheep remains vague and its popularity

300 dwindled at the beginning of the Dynastic age, the wild bull continued to play an  
301 important role in ancient Egyptian imagery. From at least the end of the Predynastic  
302 era onwards, it was a symbol of male power and virility, particularly that of the king  
303 (Hendrickx, 2002). CT scans reveal Gebelein Man A was a young man when he died  
304 (Antoine and Ambers, 2014) and may have worn the tattoos as symbols of power or  
305 strength. A cut in the skin over his left shoulder blade, as well as damage to the  
306 underlying muscle, scapula and 4<sup>th</sup> rib, suggest he died from a stab wound to the  
307 back (Antoine and Ambers, 2014). While perhaps simply a victim of interpersonal  
308 violence, the radiocarbon age range obtained from analysis of his hair (below)  
309 corresponds to the date ascribed to numerous depictions of conflict in the process  
310 surrounding the so-called unification and the establishment of the Dynastic Egyptian  
311 nation state at about 3100 BCE (Hendrickx, 2014; Bestock, 2018).

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317 **Fig. 3.** Artistic depiction of a Barbary sheep comparable to the tattoo on Gebelein  
318 Man A. The Barbary sheep carved on a ceremonial palette of the terminal  
319 Predynastic period shows the characteristic out-turned horns and hump at the  
320 shoulder as seen in the tattoo of Gebelein Man A (AN 1896-1908 E.3924 ©  
321 Ashmolean Museum, University of Oxford).

322  
323

324 The motifs tattooed on Gebelein Woman are more difficult to interpret but parallels  
325 exist in the visual culture of the second half of the Predynastic period (Naqada IIC-  
326 IID; ca. 3500-3300 BC). The linear motif on her arm is most similar to objects held by  
327 figures participating in ceremonial activities on the painted ceramics of the period  
328 (Fig. 4). They may be crooked staves, symbols of power and status, or  
329 representations of throw-sticks, or batons and/or clappers used in ritual dance (Graff,  
330 2009). This identification is complicated by the fact that such objects are never  
331 depicted alone, but always in use by a human figure. In the case of the tattoo,  
332 incised on the right arm, the woman herself may be considered to be the actor, using  
333 the implement with every movement of her arm. Such an interpretation is reinforced  
334 by the recent discovery of tattoos on the body of a woman who lived during the late  
335 New Kingdom (1186-1069 BC). On her right arm a tattoo, possibly representing the  
336 handle of a sistrum (ritual rattle), is suggested to have been so placed that she  
337 virtually shook the handle with every move (Austin and Gobeil, 2016).

338

339 The S-motif on Gebelein Woman's shoulder is also present as an element of  
340 Predynastic pottery decoration (Fig. 4) and always appears in multiples, as seen in  
341 the tattoo. Initially suggested to represent birds in flight, more recently this motif has  
342 been interpreted as an abstract element used to emphasize or connect different  
343 aspects of the composition (Graff, 2009). With this function in mind, the two tattoos  
344 found on Gebelein Woman could be viewed as a group possibly emphasizing  
345 ceremonial or ritual activities undertaken by, or on behalf of, the bearer. Their  
346 locations suggest high visibility and may have denoted status through magical  
347 empowerment or cult knowledge. The figural and hieroglyphic tattoos observed  
348 exclusively on women from New Kingdom Egypt (see Austin and Gobeil, 2016;  
349 Watson, 2016) suggest such markings were protective, amuletic or cult orientated.



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351  
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PLEASE ADD FIGURE FOUR HERE

355 **Fig. 4.** Predynastic motifs similar to those tattooed on the female mummy from  
356 Gebelein. A ritual scene painted on a Predynastic pottery jar depicts multiple S-  
357 motifs and a man holding a curved implement. Both motifs are comparable to the  
358 tattoos on Gebelein Woman. (EA 49570; Images courtesy of the Trustees of The  
359 British Museum).

360  
361 The question of tattooing in early Egypt had long been debated based on the  
362 evidence of female clay figurines, their bodies ornamented with a variety of motifs,  
363 both geometric and figural (Keimer, 1948, Bianchi, 1988; Tassie, 2003). These clay  
364 figurines are not especially prevalent in the Neolithic and Predynastic record  
365 (Stevenson, 2017) and of the roughly 250 examples, only 16 have body decorations.  
366 Of those, less than half have an excavated context. Most were fashioned with  
367 abbreviated arms or are armless, and the motifs are generally found on the torso  
368 (front and/or back) and along the legs. Only three have incised geometric motifs on  
369 their back or legs, and given the evidence of the actual tattooed bodies, the limited  
370 extent of the ornamentations and the incised method with which they were applied  
371 speak in favour of them representing tattoos (Friedman, 2017). Yet, from their rarity  
372 one might conclude that either tattooing was not a widespread phenomenon within  
373 Predynastic society or, more likely, that such personal marks were not relevant  
374 within the context these figurines were used.

375 More problematic are the Predynastic figurines with elaborate painted decoration  
376 over their bodies and face (see Hendrickx et al., 2009; Petrie, 1920). At least four of  
377 these figures have wavy lines on or near the shoulder (Petrie, 1920; Scharff, 1931;  
378 Donadoni-Roveri, 1988). These are reminiscent of the S-motif of the Gebelein  
379 Women's tattoo (Fig. 5), but the extensive nature of the other designs and their  
380 locations suggests that all or some of these motifs may represent body paint,  
381 especially in light of the clear importance given to the grinding and use of pigments  
382 during this period (Badauel, 2008).

383  
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385 **Fig. 5.** Clay figurine of a female with painted body ornamentation were previously  
386 the only evidence to suggest the practice of tattooing in Predynastic Egypt. The  
387 motifs near the shoulder may represent tattoos, but the elaborate nature of the other  
388 designs on the front (upper right) and back (lower right) of the torso may be ritually  
389 applied body paint (Turin Inv. Suppl. 1146; courtesy of Museo Egizio Turino).

390 Such figurines have generally been regarded within the realm of fertility magic.  
391 However, based on later evidence, Hendrickx et al. (2009) have suggested that they  
392 instead represent the practitioners of that magic: the musicians and dancers who  
393 performed at ritual hunting and butchery events which took place in conjunction with  
394 various other ceremonies. The authors propose that once embellished with images  
395 of the Nilotic environment on the front of their bodies, including animals and

396 vegetation, and the desert hunt featuring almost exclusively Barbary sheep on the  
397 back (Fig. 5), such performers embodied and mediated the dualities of river and  
398 desert, celebration and sacrifice, and life and death. If the actual tattoos found on the  
399 Gebelein mummies can be considered to have gender specific meaning or refer to  
400 gender specific roles, the Barbary sheep on the back of these figurines may also  
401 refer to the duality of male and female.

402

#### 403 *4.2 Dating*

404

405 The attribution of absolute dates to the phases of the Predynastic period and their  
406 correlation with radiocarbon results gathered from across the country remains  
407 problematic (Hendrickx, 2006; Dee et al., 2014). Nevertheless, the earlier part of the  
408 tattooed mummies' broad calibrated age ranges correlate well with the calendrical  
409 dates generally ascribed to the late and terminal Predynastic Naqada IID-III A phases  
410 (3400-3200 BCE) and the date modelled from the radiocarbon data for this period  
411 by Dee et al. (2013) of 3377-3238 BC ( $2\sigma$ ) (see Table 2 and Fig. 6). These are the  
412 phases within which the closest stylistic parallels for the tattooed motifs can be found  
413 (e.g. Patch, 2011). Based on the radiocarbon dates, the Gebelein tattoos are,  
414 approximately contemporary with the Alpine mummy known as Ötzi (3370-3100 cal  
415 BC; Deter-Wolf et al., 2016), and can be considered amongst the earliest surviving  
416 tattoos in the world (Figure 6). However, in contrast to the motivation suggested for  
417 some of the 61 tattoos found on Ötzi, the Iceman (Krutak, 2013; Samadelli et al.,  
418 2015), recent CT scans (Antoine and Ambers, 2014) did not reveal any underlying  
419 pathological conditions near or below the Gebelein tattoos.

420

421

422 PLEASE ADD FIGURE SIX HERE

423

424

425

426 **Fig. 6.** Probability distributions for the radiocarbon ages of the tattooed Gebelein  
427 mummies, Ötzi the Iceman (both in black) and the latter phases of the Predynastic  
428 period (Naqada IID-III A boundary; in red) with 1 and 2  $\sigma$  ranges given as lines below.  
429 Radiocarbon dates are calibrated in IntCal13 (Reimer et al., 2013), with the model  
430 and boundaries calculated using OxCal 4.2 (Ramsey, 2009).

431

432

433

#### 434 *4.3 Isotope analyses, quality controls, diet and identity*

435

436 The state of isotopic and elemental preservation of archaeological hair is not  
437 routinely tested (Lamb, 2016), but modern hair has carbon to nitrogen ratios between  
438 3.0 and 3.8 (van Klinken, 1999). The hair samples from the tattooed mummies (EA  
439 32751 and EA 32752) have, thus, slightly higher carbon to nitrogen ratios than  
440 modern specimens (Table 3). The isotopic data from the hair are similar to those  
441 from the bone collagen, with a mean  $\delta^{13}\text{C}$  value of  $-20.3\pm 0.3\text{‰}$  and a mean  $\delta^{15}\text{N}$   
442 value of  $14.3\pm 0.8\text{‰}$ . These values are enriched relative to those of bone collagen,  
443 which is the opposite of what would be expected. In fact, O'Connell et al. (2001)  
444 have shown that bone collagen is usually enriched relative to hair keratin by 1.41‰  
445 in  $\delta^{13}\text{C}$  and 0.86‰ in  $\delta^{15}\text{N}$  (although these offsets were less marked in  
archaeological specimens). However, apart from Gebelein Woman (EA 32752) for

446 whom we have data from both hair and bone, the bone collagen data were obtained  
447 from individuals who may have had different diets and lived at different times. In the  
448 case of EA 32752, provided all analyses were conducted on well-preserved tissues,  
449 the difference between the isotopic compositions of bone collagen (long term diet)  
450 and hair keratin (recent diet) may indicate either: (a) a change in diet in favour of  
451 foods from less arid environments, and/or (b) a movement from more arid areas than  
452 those present at Gebelein, and/or (c) simply that the isotopic composition of the hair  
453 reflects the diet of a time of the year when consumption was centred on resources  
454 with lower  $\delta^{13}\text{C}$  and  $\delta^{15}\text{N}$  compositions than the yearly average. Without comparative  
455 data, little more can be said, but these results present avenues for future research.

456  
457 The carbon and nitrogen isotope analyses conducted on the bone collagen and hair  
458 show that the diets of the Gebelein individuals curated at The British Museum were  
459 based on resources from habitats dominated by  $\text{C}_3$  plants. A similar result was  
460 obtained in a study of Gebelein mummies stored at the Egyptian Museum of Turin  
461 (Iacumin et al., 1996), although in this case the mean  $\delta^{13}\text{C}$  value was  $-19.4\text{‰}$  and  
462 the mean  $\delta^{15}\text{N}$  value  $12.2\text{‰}$ . A recent study by Touzeau et al. (2014) has also shown  
463 that ancient Egyptians from the Nile Valley consumed almost exclusively  $\text{C}_3$  plant-  
464 based resources and that, although the contribution of meat is difficult to estimate in  
465 these environments (given the high  $\delta^{15}\text{N}$  terrestrial plant baseline), animal foods may  
466 have contributed around 50% of dietary protein. A similar diet can be hypothesized  
467 for The British Museum Predynastic mummies, which, as mentioned above, had  
468 almost identical isotopic compositions that suggest (based on the limited data  
469 available) a level of dietary homogeneity compatible with belonging to the same  
470 cultural group and consuming locally-available foods.

471  
472 Both the  $\delta^{15}\text{N}$  values from the hair keratin from the tattooed mummies EA 32751 and  
473 EA 32752, and the bone collagen of EA 32752, have isotopic values higher than  
474 most individuals analyzed by Touzeau et al. (2014). In the absence of isotopic  
475 baselines from contemporary local fauna, it is hard to establish the origin and  
476 proportion of the animal protein consumed, but this may have included moderate  
477 quantities of terrestrial herbivore meat and/or aquatic fauna (Thompson et al., 2005).  
478 The broad dietary reconstruction for the Gebelein mummies proposed here is in line  
479 with zooarchaeological evidence for the Predynastic period, which suggests a wide  
480 range of wild and domestic animals were exploited. Fish constituted around 17% of  
481 identified fauna from Hierakonpolis, with lesser evidence that other aquatic animals  
482 and birds were also consumed here and at other sites (Guautier and van Neer, 2009;  
483 Gamza and Irish, 2012; for detailed tables see Linseele et al., 2009). In addition, the  
484  $\delta^{13}\text{C}$  values align with published archaeobotanical data and suggest that the wide  
485 range of plant foods exploited were dominated by cereals with a  $\text{C}_3$  photosynthetic  
486 pathway, such as emmer wheat and barley, and that  $\text{C}_4$  plants such as millet were  
487 rarer (Fahmy, 2005; Gamza and Irish, 2012). However, the stable isotope data for  
488 the Gebelein mummies from The British Museum contrasts markedly with those of  
489 ancient Nubian people, who consumed considerably higher proportions of  $\text{C}_4$  plants  
490 or the animals that fed on them (Thompson et al., 2008).

491  
492 Overall, the carbon and nitrogen isotope data obtained by analyzing the isotopes of  
493 the Gebelein mummies stored at the British Museum confirm that these individuals  
494 had diets typical of a largely agrarian society, such as that of late Predynastic Egypt  
495 (Hassan, 1988), and support the notion that they may all have belonged to the same

496 group. With the exception of EA 57353's high  $\delta^{13}\text{C}$  value, the isotope data range is  
497 narrow, compatible with what would be expected for a group with a similar diet. The  
498 tattooed individuals cannot, therefore, be clearly set apart from the rest of the  
499 Gebelein mummies on isotopic grounds.

500

## 501 **5. Conclusion**

502

503 Datable iconographic parallels for the tattooed motifs and the radiocarbon ages from  
504 the bodies all point towards a late and terminal Predynastic date, and confirm that  
505 the mummies from Gebelein are the earliest known tattooed individuals in the Nile  
506 valley. Isotope analyses conducted on the bone collagen and hair also suggest that  
507 their diets were similar to that observed in other Predynastic mummies (Iacumin et  
508 al., 1996), and largely based on resources from habitats dominated by plants with a  
509  $\text{C}_3$  photosynthetic pathway. With radiocarbon dates ranging from 3351 to 3017 cal  
510 BC (95.4% probability), the tattooed individuals are nearly contemporaneous with  
511 Ötzi, the Alpine mummy (3370-3100 cal BC; from Deter-Wolf et al., 2016), making  
512 them the bearers of some of the oldest surviving tattoos in the world. In contrast to  
513 Ötzi's mainly geometric tattoos, these tattoos mirror motifs found on  
514 contemporaneous figural art. Previously, only rare examples of female figurines  
515 ornamented with both geometric and figural motifs had suggested the practice of  
516 tattooing during the Neolithic and Predynastic periods in Egypt. The presence of  
517 painted or incised motifs exclusively on female figurines had led to the belief that  
518 tattooing was gender restricted and applied to women to enhance fertility. The  
519 observation of tattoos on Gebelein Man A now shows that visible body modification  
520 concerned both sexes.

521

522 We can only speculate on the method and context in which the tattoos were applied.  
523 A set of copper needles found in a Naqada III grave (Tassie, 2003) as well as the  
524 copper awls present within the burials predominately of women in contemporaneous  
525 A-Group Nubia (Nordström, 2002) have been interpreted as tattooing implements.  
526 Recent research has shown that polished bone awls are equally as effective for this  
527 purpose (Deter-Wolf and Peres, 2013), and the presence of such awls as part of a kit  
528 including pigments, resins, amulets and incense in the grave of an older woman at  
529 Hierakonpolis suggests that tattooing was in the hands of specialists and  
530 accompanied various rituals and ceremonies (Friedman, 2017). That at least two out  
531 of the seven well-preserved Predynastic mummies curated at The British Museum  
532 were tattooed may indicate that the practice was more widespread than the  
533 archaeological and artistic record allows us to see. Applied to both males and  
534 females and intended to be highly visible, the purpose of these figural tattoos may  
535 have differed between sexes, referencing perhaps status, bravery, cult/magical  
536 knowledge or protection. The exact function or meaning of these ancient indelible  
537 body marks, to both the Predynastic bearer and the viewer, remain to be fully  
538 elucidated by further discoveries. As the oldest known tattooed figural motifs, they  
539 add to our understanding of the range of potential uses of tattoos in pre-literate  
540 societies, provide new media and context for understanding visual language at the  
541 dawn of Ancient Egyptian civilization and expand our view of the practice of body  
542 modification in prehistoric times.

543

544

545

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547

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559

560

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