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1 **First identification of non-human stencil hands at Wadi Sūra II (Egypt): a**
2 **morphometric study for new insights into rock art symbolism**

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16

17 **Abstract** In the Libyan Desert, Wadi Sūra II shelter hosts numerous stencil paintings believed
18 to date to the Early and Mid-Holocene. Tiny hands have previously been considered to belong
19 to human babies. We challenge this identification, having conducted a morphometric study to
20 compare the archaeological material with samples of hands of babies born at term and pre-
21 term at the neonatal unit of the CHRU Jeanne de Flandre (Lille, France). The results show
22 that the rock art small hands differ significantly in size, proportions and morphology from
23 human hands. Potential biases between the different samples were quantified, but their
24 average range cannot explain the observed differences. Evidence suggest that the hand
25 stencils belong to an animal, most probably a reptile. The identification of non-human
26 pentadactyl hand stencils is unique in the field of rock art and raises new perspectives for
27 understanding the rock art at Wadi Sūra, and the behaviour and symbolic universe of the
28 populations who made it.

29 **Keywords** Morphometry; Hand stencils; Rock art; Prehistory; Sahara.

30

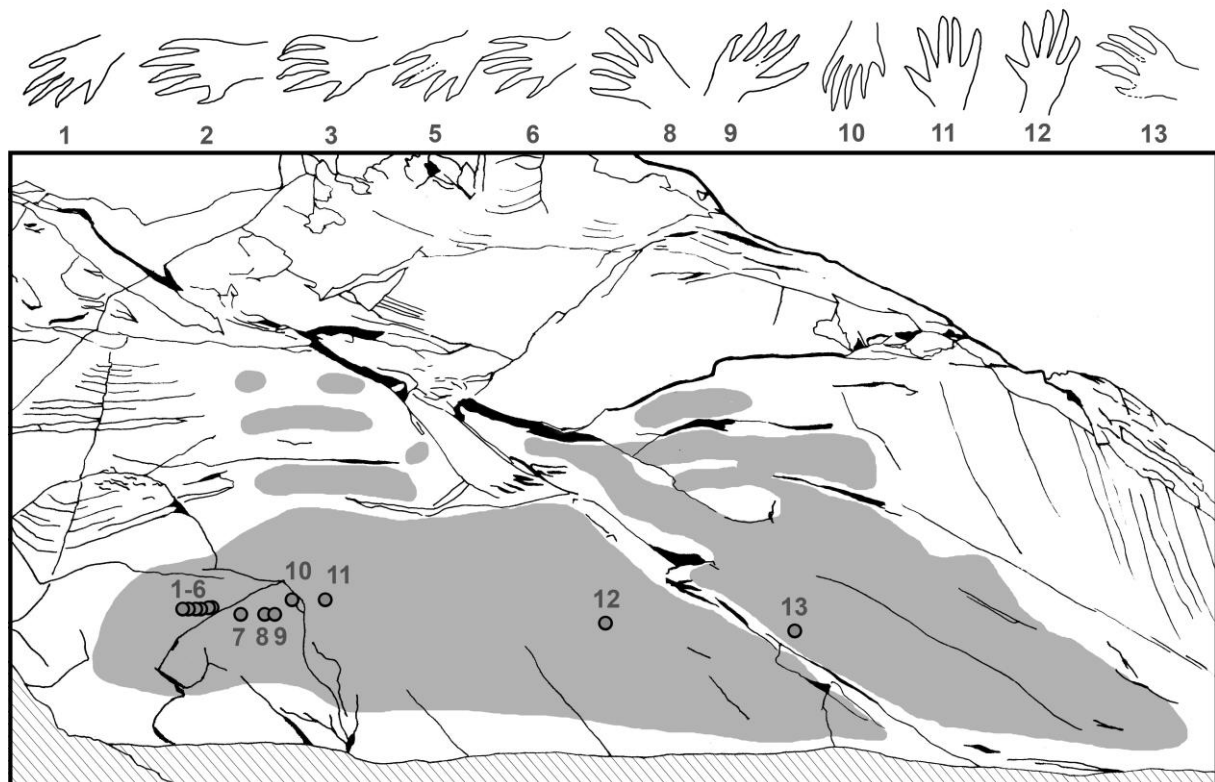
31 In the Egyptian part of the Libyan Desert, erosion processes have shaped the great plateau of
32 the Gilf el-Kebir (tabular surface of ca. 15 000 sq. ft - 7500 sq. km), mostly composed of
33 Tertiary Nubian sandstones¹. This massif is surrounded by flat sand sheets to the East, the
34 South and the West, and by the Great Sand Sea to the North. The plateau is deeply incised by
35 numerous wadis, the flanks of which host natural shelters. In some of them, prehistoric rock
36 art, paintings, stencils and engravings, can be seen on the walls, dating mainly from the Early
37 and Mid-Holocene periods, called the “optimum”, corresponding to the latest favorable
38 interval².

39 The shelter of Wadi Sūra I (improperly called “cave of swimmers”) was discovered in 1933
40 by Laszlo de Almasy³. In the same area, a second – better preserved – great shelter was found
41 in 2002 by J. & M. Foggini⁴. Also called WG 21 according to the classification of A. Zboray⁵,
42 the shelter of Wadi Sūra II is situated at the top of a dune overlooking a *playa* with alternating
43 sediments from a former palaeolake formation. The shelter is a 20 meters large space, 8 m

44 deep, defined by the rocky overhang and totally open to the outside, making the denomination
45 “shelter” much more correct than the commonly used “cave”^{6, 7}. On the wall, a central panel,
46 up to 4 meters high above the floor, is covered mainly by paintings on a surface of nearly 100
47 sq. m. With more than 8000 figures and a very high number of superimpositions, Wadi Sūra II
48 can be considered as the greatest – or one of the greatest – rock art site of the whole Sahara.

49 Among its oldest paintings, the Wadi Sūra II shelter contains a very high number of stencil
50 paintings including hands, arms, feet, disks and sticks⁸. The number of hand stencils has been
51 previously estimated at around 120 or 400^{9, 10}, but according to our own count there are about
52 900. Thirteen of these hand stencils are quite tiny. Eleven are located in the left part, and two
53 more are scattered on the first third of the right side of the wall, close to the main oblique
54 crack (Fig. 1)

55 **Figure 1: Drawing and location of the small hand stencils in the Wadi Sūra II shelter. In**
56 **grey, the areas with rock art. Hand stencils 4 and 7 could not be completely**
57 **reconstructed.**



58

59 They have been identified by Le Quellec and others¹¹ as being the hands of human babies or
60 very young children. However, the atypical profile, the very small dimensions and the
61 unexpectedly elongated proportions of these small hands led us to undertake a more precise
62 identification of the stencils (Fig. 2). The average length of the small hands is 45.3 mm from
63 the base of the palm to the end of the medius digit. The fingers are longer than the palm and
64 they get progressively thinner distally, ending pointed. The aim of this study was to determine
65 if the small hand stencils on Wadi Sūra II walls are human. For this purpose, we have
66 compared the morphology of these small hands with human hand reference samples.

67

68 **Figure 2: Small hand stencils previously identified as human babies stencils. The**
69 **particular layout of tiny hands in the pair of human hands seem to indicate a close**
70 **relationship.**



71

72 Hand stencils are a very common pattern in the rock art record. They were likely made by
73 placing a hand or animal foot on the surface rock, and then blowing a pigment onto the
74 substrate, to create an outline or a negative image of the hand or foot. As most hand stencils
75 were made from human hands, morphometric studies on the archaeological record has
76 concentrated so far on determining the relation of morphometric criteria of shape and size
77 with group characteristics among humans¹²: biological sex¹³ and age. Experiments have
78 shown that some methods for determining sex according to morphometric criteria can be
79 successful at a rate exceeding 85%¹⁴. Our study focuses on an interspecific issue. We describe
80 hand morphology in anthropometric terms, using both measurements and proportions (termed
81 as ratios). Due to the differing nature of the samples, potential biases can occur and we tried
82 to quantify their impact.

83 **1. The samples**

84 Five samples have been established (Tab. A1). *Sample A* is the archaeological sample of
85 small rock art hands in Wadi Sūra II that we want to identify. Two individuals have not been
86 taken into account as they were incomplete (Fig. 1). *Sample B* is constituted of 36 hands of

87 living babies born at term, measured at birth, from 37 to 41 weeks gestational age. *Sample C*
88 is made of 25 hands of living pre-term babies, measured at birth, from 26 to 36 weeks
89 gestational age (see Tab. 1 & 2 in Ref [15]). *Sample D* is the archaeological sample of 30 rock
90 art large stencil hands from Wadi Sūra II, presumed to be blown from human adult hands.
91 *Sample E* is made of 30 hands of a current adult human population, measured on living
92 individuals.

93 For the archaeological samples (*A* and *D*), measures were taken directly on the wall. The
94 morphometric data gained from the human new-borns (*B* and *C*) were collected in the
95 Neonatology Unit of the CHRU Jeanne de Flandre (Lille University Hospital, France)
96 between January and May 2014. Morphometric data on current adult hands (*E*) were collected
97 according to the same protocol at the same hospital in June 2014.

98 **2. Methods: the observational study & the measurements**

99 The hypothesis to test was that these small hands would belong to young humans or human
100 babies. We compared *Sample A* with *Samples B* and *C* in order to determine to what extent
101 they are similar and, thus, the probability that the small stencils of Wadi Sūra II could have
102 been made by blowing paint on the hands of human babies. We then compared *Sample D* with
103 *Sample E*, to determine and quantify the potential variations between measures taken directly
104 on hands of a current European population, and measures taken on hand stencils of a North
105 African population from the Holocene.

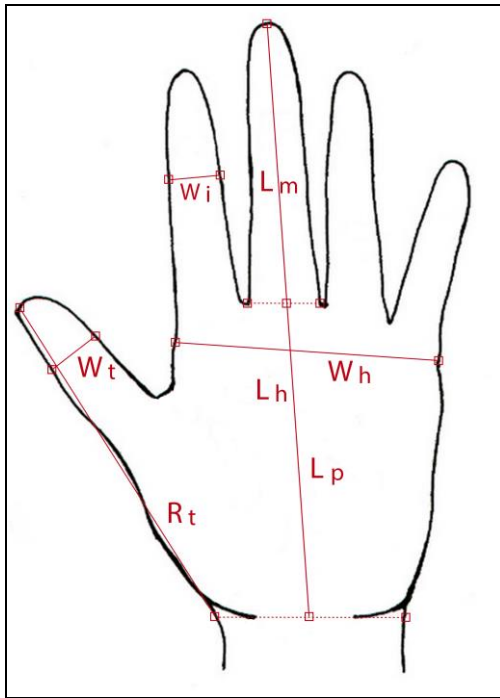
106 The sex of the individuals was not considered in the comparison, since the estimation of sex
107 from hand stencils based on the Manning index¹⁶ and related methods involving
108 measurements are applicable to human hands only. Measurements were also taken regardless
109 of the side (right or left hand) since this factor is not statistically significant enough to impact
110 or change the results at the scale of the study. Actually, according to a morphometric study
111 led by E. Nowak on a child population, morphometric differences between right and left
112 hands are less important than differences of hand measurements between males and females¹⁷.

113 We have selected the measurements criteria in accordance with the data available in the
114 archaeological sample. Some of them are similar to measurements previously used by Snow¹³,
115 Chazine and Noury¹⁸, and Sinclair *et al.*¹⁴ in the framework of other methods and purposes. In
116 this study, 7 measurements were taken with a sliding caliper on each individual (Tab. A2,
117 fig. 3):

- 118 - W_i = width of the second digit (index) measured at the mid phalanx, just above the
119 proximal inter-phalangeal joint.
- 120 - W_t = width of the first digit (thumb) measured at the middle of the proximal phalanx.
- 121 - R_t = Ray of the first digit (thumb) measured from the proximal end of the hand palm
122 to the distal end of the thumb
- 123 - L_m = length of the middle digit, measured from the base of the digit
- 124 - L_p = length of the palm of the hand, measured from the proximal end of the hand to
125 the distal end of the middle finger
- 126 - L_h = maximal length of the hand, measured from the proximal end of the hand to the
127 distal end of the middle digit
- 128 - W_h = width of the hand, measured on the palm, just below the joint between the
129 metacarpals and the proximal phalanges.

130 This formula can be checked: $L_h = L_m + L_p$. And following this formula, the ratio L_p / L_h
131 has to be inversely proportional to the ratio L_m / L_h .

132 **Figure 3: Measurement criteria taken on *Samples A, B, C, D* and *E*.**



133

134 **3. The comparative study**

135 **3.1. Comparison with the hands of newborns**

136 Using a combination of two statistical tests, we tried to determine whether *Samples A* and *B*
137 belong to a unique cluster or to two distinct populations. At first, with a Fisher-Snedecor test
138 we have assessed the homoscedasticity of *Sample A* and *Sample B* for the seven variables
139 (Tab. A3). Variances can be considered as almost identical since p-values vary from 0.05 (for
140 W_h) to 0.58 (for W_i). W_h and L_h have the lowest p-values and the variances are higher for the
141 newborn sample than for the archaeological one. Then, in order to compare the average
142 measurements for each parameter between the two samples, a T-test was performed since the
143 samples are independent, small and of different sizes. The results show that, according to the
144 parameters, *Sample A* and *Sample B* have between less than 0.39% (parameter W_i) and less
145 than 0.01% (parameters W_h , L_h , L_p and L_t) chance to get the same averages. On eight criteria,
146 four score less than 0.01% probability. This means that *Samples A* and *B* have an extremely
147 low probability to represent the same population.

148 It can be observed that the newborn hands are all much longer (average length = 62.01 mm)
149 than the small negative hands (average length = 45.33 mm) (Tab. A6). This raises the
150 hypothesis that the small negative hands could be from smaller individuals, maybe from
151 fetuses or pre-term newborns.

152 **3.2. Comparison with pre-term newborns hands**

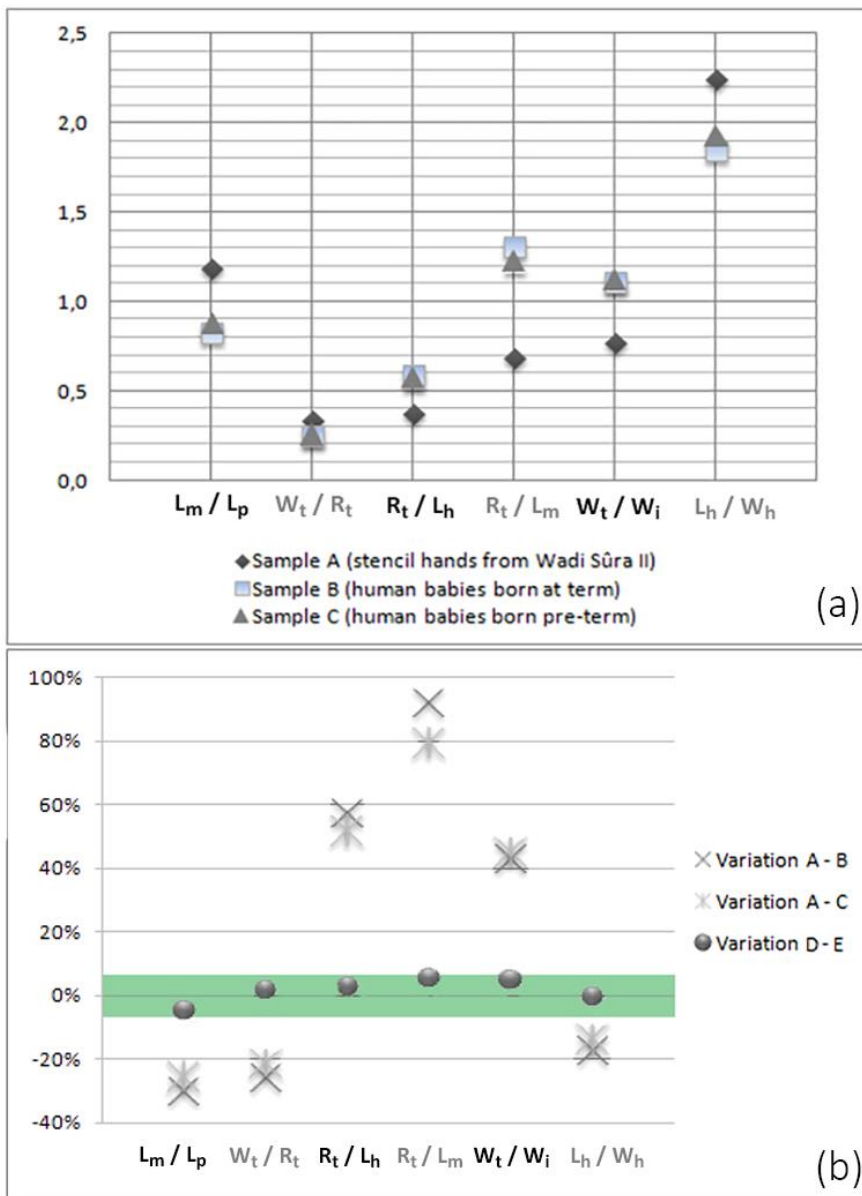
153 We compared the *Samples A* and *C* with the same method (Tab. A4). The p-value is below the
154 critical threshold of 0.05 for the parameters L_t (= 0.024) and W_h (= 0.02). Some parameters,
155 especially the width of the index and the length of the medius, do not exclude that the two
156 samples could be from the same population. But again four criteria on eight score less than
157 0.01% probability, which has led us to conclude that *Sample A* and *C* have an extremely low
158 probability to represent the same population. Concerning proportions, *Sample B* and *Sample C*

159 seem to be very close, whereas *Sample A* significantly differs on 6 kinds of average ratios
160 (Tab. A7, fig. 4). This means that hand proportions do not greatly vary between the pre-term
161 babies and the newborns at term; but they are significantly different from the proportions of
162 *Sample A* hands.

163

164

165 **Figure 4: (a) Proportion differences between the small stencil hands and human babies**
 166 **hands, (b) Variation of the proportions between the samples.**



167

168 **4. Consideration of potential biases**

169 Potential biases could affect the data in the comparisons of measurements. The main bias
 170 would result from the fact that the data of *Sample A* have been taken on a painting result,
 171 whereas measures for *Samples B* and *C* have been taken directly on hands. Other potential
 172 biases can be stressed, such as anthropomorphological differences between the Early or Mid-
 173 Holocene populations and the modern populations, or differences due to the geographical
 174 origin of the samples. To what extent could these potential biases affect the results?

175 If we assume as an initial postulate that potential biases arise regardless of the age of the
 176 individuals, we could try to measure the degree to which they affect the results by comparing
 177 on the same parameters 30 large hand stencils from Wadi Sūra II (named *Sample D*) with 30
 178 hands of a current adult population (*Sample E*) (Tab. A2). The aim was to quantify the
 179 average impact of the biases between the two distinct populations. The results of the T-test are
 180 very heterogeneous depending on the parameters and thus inconclusive (Tab. A5). We

181 calculated the variations between the *Samples D* and *E*. If the differences between the *Sample*
182 *A* and the *Samples B* and *C* are due to these biases, we would expect that the variations of
183 proportions or size would be roughly in the same range from the stencil object to its painting.

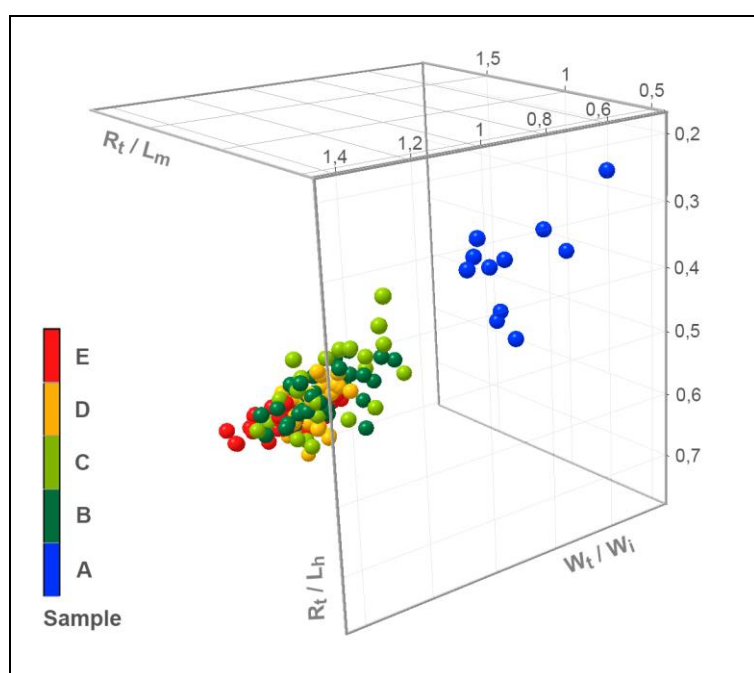
184 The results show that the variations between the small hands blown in the shelter and the
185 hands of pre-term and at term babies are much higher than the variations observed between
186 human adult hands and large hand stencils from Wadi Sūra II shelter. The biases on adult
187 hands do not exceed a 5.5% average deformation, from the hand to its stencil (Fig. 4b, Tab.
188 A8). The conclusion is that potential biases cannot solely explain the differences that we have
189 observed between the small stencil painted hands and the hands of young humans.

190 5. Hand morphology and proportions study

191 On the Wadi Sūra II small stencil hands, the ray of the thumb (first digit) is rather short, in
192 comparison to the length of the medius (third digit) as well as to the length of the hand (Fig. 5,
193 tab. A7). We also note that the anatomical position of the thumb is also quite different
194 (Fig. 2). On the stencil hands, the base of the thumb lays in the proximal alignment of the
195 metacarpals; whereas on human hands, the thumb is not aligned with the other fingers and
196 appears to be more opposable. This constitutes a serious anatomical argument to exclude the
197 possibility of human hands. A 3D graph gathering the five samples according to three
198 featuring ratios (Fig. 5) shows that all the human hands (both modern hands and
199 archaeological stencil hands) gather in a single cloud, while hands from *Sample A* are
200 scattered outside of the group. Hand proportions clearly differ between the human samples
201 (*Samples B, C, D, E*) and the other group (*Sample A*).

202 In conclusion, the small stencil hands of Wadi Sūra II have an extremely low probability of
203 belonging to human babies or fetuses, and the differences observed cannot be explained by
204 distortions that are due to potential biases.

205 **Figure 5: 3D-Plot of the samples according to three ratios (XLStat 2015). Sample B, C, D**
206 **and E gather in a cloud, showing that the morphological proportions of human hands**
207 **are in the same range, whether adult or babies, hands or stencils. Sample A dots are all**
208 **outside the cloud of human hands proportion.**



209

210 **Figure 6: Hands of (a) a newborn from sample B, (b) a 4-year old *Crocodylus* from the**
 211 **zoological garden of the University of Tel Aviv, (c) an adult *Varanus griseus* from the**
 212 **wild, (d) an adult *Varanus griseus* from the Zoo of Moscow - palm length 25 mm.**



213

214

215 **6. Alternative hypotheses**

216 Alternative hypotheses are those of a modeled hand (made from wood, clay or any other
 217 material), animal hands, or modified stencils. The individual and collective postures of the
 218 fingers and phalanxes, according to criteria of functional morphology and biomechanics, are
 219 consistent with an articulated hand. The position of every finger and the distance between
 220 them also differ a little bit from one hand to another, which is particularly visible on the frieze
 221 (*cf. infra* & Fig. 1). No trace of retouch is visible. It could corroborate the hypothesis of the
 222 stencil being a hand of a creature - whether dead or alive - with pentadactyl hands or feet, like
 223 non-human primates (small monkeys), other mammals, or reptiles. Young *Cercopithecidae*
 224 are matching in terms of hand length and elongated proportions¹⁹ but the thumb on their hands
 225 is opposed, as it is in human hands²⁰, and the finger tips are usually not so pointed.

226 On purely morphometric criteria, the most compelling comparisons are found among reptiles,
 227 and especially either young crocodile (*Crocodylus sp.*) or varan forefeet (*Varanus sp.*)
 228 (Fig. 6). *Varanus* forefeet are much smaller than their hindfeet, whose morphological
 229 proportion are differing, so that only the forefeet of *Varanus sp.* could match with Wadi
 230 Sūra II stencils. In the desert or semi-desert area of the Gilf el-Kebir, *Varanus griseus griseus*
 231 is the most likely subspecies due to its known distribution range and its natural habitat²¹, but a
 232 crocodile's forefoot is not to be excluded since it could have been transported. Nile crocodile
 233 is evidenced across the Sahara during the Holocene by rock art²² and bone remains²³, and was
 234 still found alive in the Tibesti²⁴ and the Tassili in the early XXth century²⁵.

235 On each hand from *Sample A*, fingers show important length differences which would rather
 236 fit with the morphological specificities of crocodile or varan hands/forefeet (contrary to
 237 primate hands), having unequal numbers of phalanxes: respectively 2-3-4-4-3 and 2-3-4-5-3²⁶.
 238 Distal phalanxes terminate in a pointed horny claw whose shape conforms to the tip of
 239 *Sample A* digits. We compared the measurements of *Sample A* with a *Varanus griseus griseus*
 240 adult and male specimen from the Steinhardt Museum of Natural History of Tel Aviv
 241 University. Out of the seven measurements taken on its forefeet, six match the dispersion of
 242 *Sample A* ($W_i = 5,4$; $W_t = 4,5$; $L_m = 26,5$; $L_p = 19,5$; $L_h = 46$; $W_h = 23$), and one ($R_t = 26$) is
 243 below the threshold of 5% probability. A comparative morphometric analysis with juvenile
 244 crocodiles is in progress.

245 **7. Discussion and conclusion**

246 Animal hand or foot stencils are not as common as human ones in the rock art record. Emu
 247 foot stencils are evidenced in the Carnavon Gorge and the Tent Shelter in Australia,

248 choike/nandu (birds of the genus *Rhea*) stencils in the rock art of *La Cueva de las Manos* in
249 Argentina, bird stencils in Arnhem Land in Australia²⁷, among others. All these animal
250 stencils are made with tridactyl feet. As such, as far as we know, the Wadi Sūra II shelter
251 would represent the first record ever identified of non-human pentadactyl hand stencils in the
252 world rock art.

253 As for chronology, the hand stencils of Wadi Sūra II relate to the earliest phases among rock
254 paintings on the shelter wall²⁸. No direct dating of the painting has been done so far, however
255 according to the relative chronology and contextual evidence, this phase could be placed
256 tentatively into the second half of the VIIth millennium BC and the VIth millennium BC,
257 around 6000 BC²⁸. Representation patterns suggest that the very small hand stencils are most
258 probably contemporaneous with the adult ones. The layout of the tiny stencils is significant.
259 They are all located approximately at the same height, at around 1.80 m above ground level as
260 it was at the time of the discovery of the shelter. Five of them are aligned in the same
261 direction like a frieze (Fig. 1). Their total number is only 13 out of about 900 stencils, this
262 means less than 1,5%. If the same hand was used for stencilling, this could represent an
263 isolated experience, done once, maybe using a unique animal hand.

264 The varan is an animal associated with a strong symbolic universe amongst Saharan and
265 Sahelian populations, who represented it in rock art^{29, 30}. For André Jodin, “*the sacred nature*
266 *of this animal for the [subactual] Libyan populations is undoubtful*”³¹. Varans appear as
267 protective animals to which various functions are assigned: chthonian animals related to the
268 founding of the villages and to origins in general, protective or apotropaic body parts worn as
269 amulet by the Tuaregs, etc. Crocodiles are also linked to old-established beliefs about
270 creation, destruction or regeneration, mainly recorded in the Nile Valley. Both animals have
271 not yet been identified by archaeology - whether in rock art or by bone remains - in the Gilf
272 el-Kebir.

273 Whereas other shelters of the region mostly display scenes of everyday life (pastoralism,
274 hunting), Wadi Sūra II is host to numerous paintings whose content is more obviously
275 symbolic, such as composite beasts. The presence of animal stencils in this particular shelter
276 suggests that they could have been done in the context of paintings expressing beliefs related
277 to nature. The particular layout of the pair of tiny hands in the pair of human hands seem to
278 indicate a close - if not fusional - connection between animals and human, in the generic sense
279 of the term (Fig. 2). Our identification of the use of an animal (most probably a reptile) hand
280 or forefoot as a stencil in the rock art of Wadi Sūra is a significant discovery that sheds a new
281 light on the symbolic universe of the Early Holocene populations from the Eastern Sahara.

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354 **Supplementary information** The appendix is composed of 8 tables of data (A1 to A8).

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