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THE DEVIL'S TOUCH: A FIRST DATASET FROM WHAT COULD BE THE OLDEST HUMAN HANDPRINT EVER FOUND (CENTRAL-SOUTHERN ITALY)

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ABSTRACT: This paper aims to report about all collected data and information on the human handprint firstly identified at Tora e Piccilli palaeoichnological site (Tora-Piccilli, Caserta, Central Italy) i.e. within the same site in which Middle Pleistocene (about 350 ka) human fossil footprints (the so called "Devil's Trails") are preserved. As well-known, these footprints are not randomly patterned, but are organized into at least two long trackways, called A and B. During first surveys of the site, in the middle of the Trackway B, aside the traces of a long fossil slide, it was noted a hollow: it was preliminary thought to be the print of a left hand used by the trackmaker to regain lost balance. Even if this possibility seemed to be very probable, it has remained a simple hypothesis and has been, for a long time, waiting for a scientific confirmation. After many years of careful studies, we have enough data to confirm that the first impression was correct and to report about what is, so far, the oldest human fossil handprint in the world. A first set of dimensional data is also given. They are precious in the sight of each future study about the upper limbs of prehistoric humans.

Keywords: fossil, handprint, Roccamonfina footprints, Devil's Trails

1. INTRODUCTION

The human fossil footprints, commonly known as "Devil's Trails", were discovered in 2001 on a deposit of brown Leucitic tuff (BLT) located in the Roccamonfina volcanic area (Central-Southern Italy) [41° 19.954'N - 14° 1.489'E] (Fig. 1), and published by Mietto et al. (2003). At the time of their first publication, they were the oldest established human footprints left by some exemplars of the genus "Homo" (Mietto et al., 2003; Avanzini et al., 2008). Currently, even after the discovery of other older human footprints at Ileret/Koobi Fora (Kenya) (Bennett et al., 2009), at Happisburgh (UK) (Ashton et al., 2014).) and, probably, at Aalad-Amo (Eritrea) (en.uniroma1.it/archionotizie/homo-erectus-extraordinary-footprints), the "Devil's Trails" remain among the oldest ever found in the whole world, since they have been radiometrically dated at 349±3 ka by 40Ar/39Ar method (Scaillet et al., 2008; Santello, 2010).

The "Devil's Trails" are associated with paleofauna footprints of the same age (Panarello et al., 2017b; Palombo et al., 2018) and, unlike all the other human fossil footprints known up to now, are not located on a flat or moderately inclined surface, but on a very steep slope (Fig. 2a) which, in some areas, also reaches inclination close to 80%. Moreover, the same footprints are not randomly organized but are patterned in several trackways (Mietto et al., 2003; Avanzini et al., 2008). In particular, the Trackway A and the Trackway B are both descending and branch off from a fossil pathway that

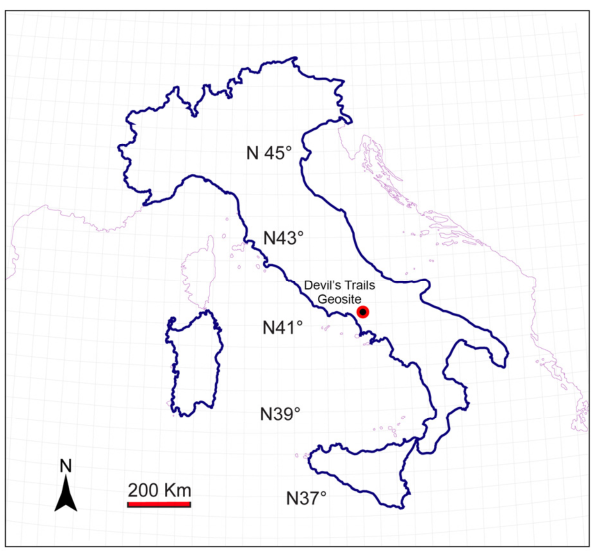

Fig. 1 - Location of the Tora and Piccilli ("Devil's Trails") geosite.

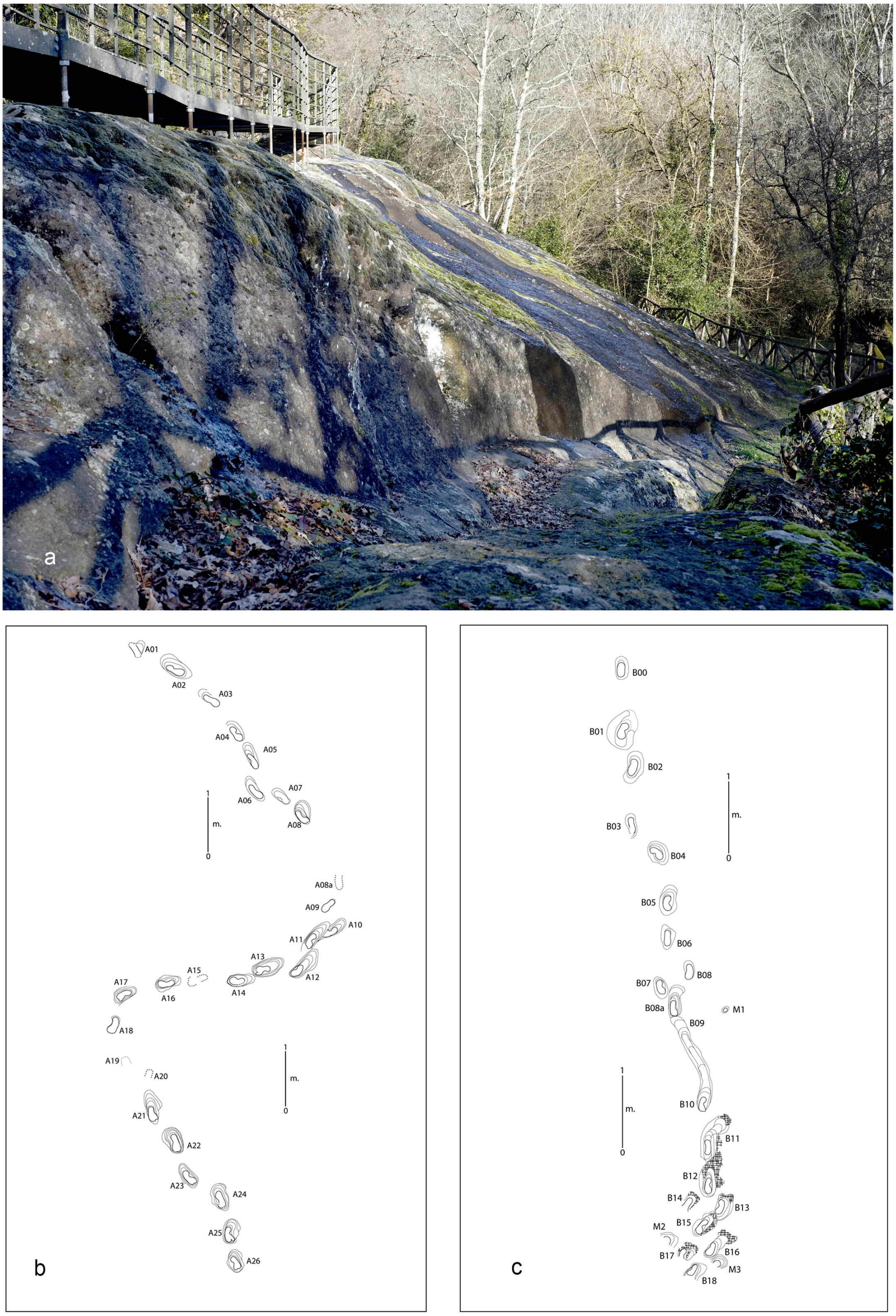

Fig. 2 - a) Devil's Trails Geosite: western view of the steep slope of BLT on which the fossil footprints and handprints are preserved; b: Pattern of the Trackway A (scale-bar: 1 m); c) Pattern of the Trackway B (scale-bar: 1 m).

Fig. 3 - The left hip impact zone in the middle part of the Trackway B, with very evident preserved mud-crack.

dominates the whole slope. This pathway has been proven to be the oldest in the world to date (Panarello et al., 2017a). Trackway A and Trackway B have very particular patterns that cannot be so far compared to similar ones in the entire world (Fig. 2 b, c). These patterns clearly reflect the conscious behavioral choices that the two trackmakers had to make to preserve their balance during the descent of an unsafe, sloping and slippery slope. The trackmaker A descended in a "zig-zag" way, describing a "Z" shaped route (Fig. 2b). The trackmaker B, due to misleading and unsafe ground, which was not regularly dry (as revealed by mud-crack areas) (Fig. 3), slipped for more than 90 cm losing his/her balance, but he/she did not fall: this is revealed by the total absence of traces of an impact on the surrounding ground (Fig. 2c).

During the slide, in order to regain the lost balance, he/she had to rest his/her left hand and also his/her pelvis on the upstream side in order to proceed with his/her descent (Fig. 4).

Based on this evidence, the small deep and elongated cavity, located to the left of the slide, was firstly interpreted as the print left by the carpal area of a left hand. Indeed, it has rounded edges and lies in a

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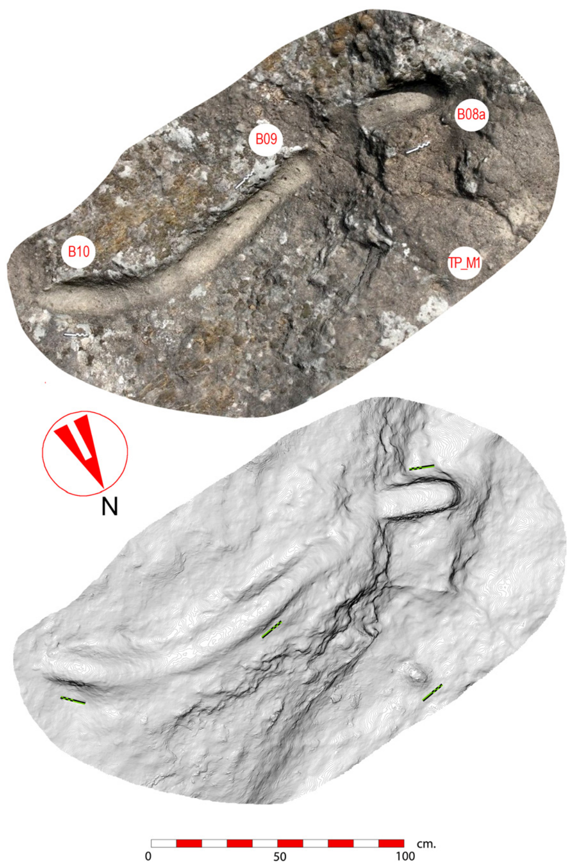

Fig. 4 - The middle area of the Trackway B, with the long slide, the TP_M1 handprint and some footprints (scale-bar: 1 m; contour lines: 1 mm).

FIGURED MODEL	Figure	Number of images	Camera Model	Image Resolution	Focal Lenght	Error	Resolution
B08	4	8	Canon PowerShot G9	4000 x 3000	7,4mm	0.5175 pix	0.000475237 m/pix
B08a	4	9	Canon PowerShot G9	4000 x 3000	7,4mm	0.601952 pix	0.000493607 m/pix
B09	4	64	Canon EOS 550D	5184 x 3456	18-50mm	0.782356 pix	0.00224265 m/pix
B10	4	12	Canon PowerShot G9	4000 x 3000	7,4mm	0.632863 pix	0.000420919 m/pix
TP_M1	6, 7, 8	16	Canon EOS 550D	5184 x 3456	18-90mm	0.820102 pix	0.000364915 m/pix

Tab. 1 - Parameters of the photogrammetric models of the handprint TP_M1 and of its immediate surroundings.

position compatible with the estimated height of hominine B (Mietto et al., 2003; Avanzini et al., 2008).

Although this interpretation immediately seemed the most realistic, it was decided to proceed with a more in-depth study by applying also the most innovative techniques according to the most recent palaeontological protocol (Falkingham et al., 2018), in order to carry out all necessary checks for its final authentication. Thus, through 3D modelling, carried out on the basis of highly detailed photogrammetric surveys, it was possible to see that the print of some parts of all trackmaker's left hand five fingers are visible. These prints branch from the most evident carpal hollow. Although the degree of preservation is not the same for all fingerprints and each measurement always must be considered interpretative, the dimensional collected data seem to be certainly compatible with those up to now known for humans (Garrett, 1971; Marzke & Shackley, 1986; Aiello & Dean, 1990; McHenry, 1992; Lorenzo et al., 1999; 2015; Marzke & Marzke, 2000; Jones & Lederman, 2006; Buryanov & Kotiuk, 2010; Gilsans & Ratib, 2012; Almécija et al., 2015). Scientists' first impression was, hence, correct. So, the provided both structural and dimensional details which are given here, as they are referred to such an antique handprint, called TP_M1 ("Tora and Piccilli's Manus 1"), may reveal precious for any further study.

2. METHODS, TECHNIQUES

The handprint TP_M1 and its immediate surroundings were georeferenced with a Garmin Etrex 10 detector (accuracy ±3 m) and carefully photographed through Canon Powershot G9 and Canon EOS 550D camera with CANON EF-S 18-200 lens. Then all the pictures were processed with Agisoft Photoscan Pro and Kitware Paraview to create detailed 3D models of the general examined surface following the procedures of Mallison & Wings (2014) and Belvedere et al. (2013). These models have been scaled through a metallic 10 cm scale-bar. Each parameter of the figured models is shown in Table 1 according to the method of Lockley et al. (2015).

3. DESCRIPTION

If we observe the hollow referable to the carpal zone of a left hand, which is the most evident part of the handprint TP_M1, we immediately notice that the whole handprint was created by the trackmaker during an unexpected slide on the slimy ground. Moreover, it appears completely and very easily superimposable by the left hand of a young boy/girl or by the left hand of a minute woman of present time. The prehistoric hand of the Middle Pleistocene trackmaker, indeed, was already anatomically structured in the way we know for present humans and fully coordinated with the brain. Also, it was completely capable to do simple and/or complex movement, to achieve a result thought and desired (Jones and Lederman, 2006; Navsa, 2010; Gilsans & Ratib, 2012). For these reasons and considering that the human hand is the upper limb that has changed less during evolution (Marzke & Shackley, 1986; Aiello & Dean, 1990; McHenry, 1992; Marzke & Marzke, 2000; Almécija et al., 2015), a glance is sufficient to imagine the moments of the hand's support on the muddy steep ground without straying too far from reality.

The most evident part of the TP_M1 handprint (Figs. 5, 6, 7, 8) is elliptical in shape, with flared and

Fig. 5 - Tora and Piccilli geosite: western detail photo of the carpal zone of the handprint TP_M1.

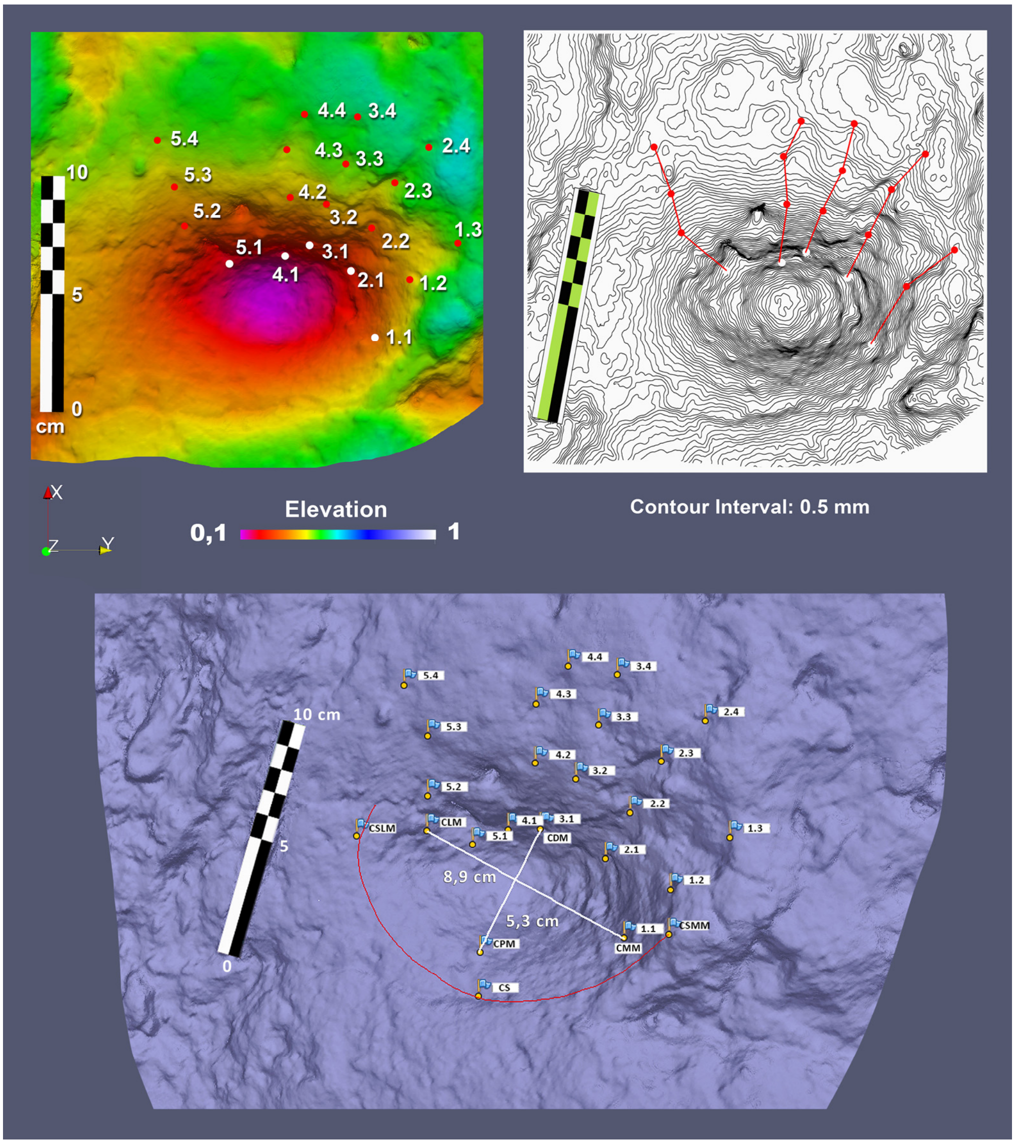

Fig. 6 - TP_M1 handprint: a) Depth map with landmark positions; b) Contour map (interval: 1 mm) with highlighted (red lines) the possible directions of the fingers; c) detailed landmark map.

smoothed edges. This part is limited downstream by a quite semicircular displacement rim. The direction of the major axis of the handprint is incident to the progression line of Trackway B that here runs southeast. The rear area of the handprint shows the signs of an anteromedial slip oriented towards the incline, while the distal area shows the signs of an irregular compression loaded onto the front. In this area a series of small, elongated and partially irregular in shape depressions aligned in 5 directions is visible. Each depression is divided into several segments: they are, in number, 3 for the 4 directions corresponding to fingers 2-5 and 2 for the direction corresponding to the thumb.

The directions of the 5 fingerprints appear patterned in an irregular way. This could be explained by considering that they were likely created as a consequence of the responding to an instinctive impulse, which was induced by the unexpected loss of the general balance. For the same reason, the greater load was carried on the carpo-phalangeal area of the first and second fingers (Fig. 8), whose prints are the best preserved ones. The dimensional and structural details of each element, as interpreted by us, are shown in Tables 2 and 3. In reading and evaluating them, it should be taken into the right account that the collected dimensions refer to the handprint and not to the bones or to precise muscles and joints, so they can slightly vary with respect to those recorded by corresponding hand bones. They are also affected by the substantial irregularity of the solidification and alteration of the substrate, which is very evident somewhere within the geological site (Avanzini et al., 2008). Furthermore, it must be taken into the same account that the trackmaker was sliding and that put his/her left hand instinctively and

Ref. Fig. 6, 7	Segment Area	Measured Lenght (cm)
1.1-1.2	Os metacarpale I	2.7
1.2-1.3	Phalanx proximalis I	2.8
	Phalanx distalis I	uncertain
2.1-2.2	Os metacarpale II	2.3
2.2-2.3	Phalanx proximalis II	2.3
2.3-2.4	Phalanx media II	2.0
	Phalanx distal II	uncertain
3.1-3.2	Os metacarpale III	3.2
3.2-3.3	Phalanx proximalis III	2.2
3.3-3.4	Phalanx media III	1.9
	Phalanx distal III	uncertain
4.1-4.2	Os metacarpale IV	3.6
4.2-4.3	Phalanx proximalis IV	2.2
4.3-4.4	Phalanx media IV	1.8
	Phalanx distal IV	uncertain
5.1-5.2	Os metacarpale V	2.7
5.2-5.3	Phalanx proximalis V	2.4
5.3-5.4	Phalanx media V	2.1
	Phalanx distal V	uncertain
CLM-CMM	Carpal Lateral Margin Carpal Medial Margin	8.9
CPM-CDM	Carpal Proximal Margin Carpal Distal Margin	5.3
CSLM-CSMM	Carpal Strike Lateral Margin Carpal Strike Medial Margin	12.9

Tab. 2 - Handprint lenghts (conventions after Artner, 2002)

Ref. Fig. 8	Segment Area	Measured Widths (cm)
w1.1L-w1.1M	Phalanx proximalis I	1.76
w2.1L-w2.1M	Phalanx proximalis II	1.73
w2.2L-w2.2M	Phalanx media II	1.44
w2.3L-w2.3M	Phalanx distal II	1.35

Tab. 3 - Handprint widths (conventions after Artner, 2002)

dynamically. For these reasons, the depression-areas created by the supports of the hand-joints may appear slightly dilated and/or deformed if compared to those usually recorded both for present and ancient men starting from their bones. The parts of the hand which are somehow uncertain in being recognized have been voluntarily ignored. The dimensions collected and shown in Table 2 have been measured, hence, within the handprint area from what are likely one joint-zone to the following one. These zones have been identified by using the 3D models and the Depth and Planar Contour maps shown in Figs. 6, 7, 8. In order to mostly reduce the margin of error during interpretation of each linear length, the limits of the joint zones have been identified by different observers and, specifically, by one of the authors (L.M.), who is a M.D. hand surgeon. Even if the cornerstones of each dimensional data preserve reasonable margin of interpretation, we think it can be considered affordable enough.

Similarly, the fingers widths have been measured as the straight distances between the interphalangeal joints edges, but only in the places in which such measurement can be considered affordable enough (Fig. 8). These values are shown in Table 3.

Finally, it has been measured the straight distance

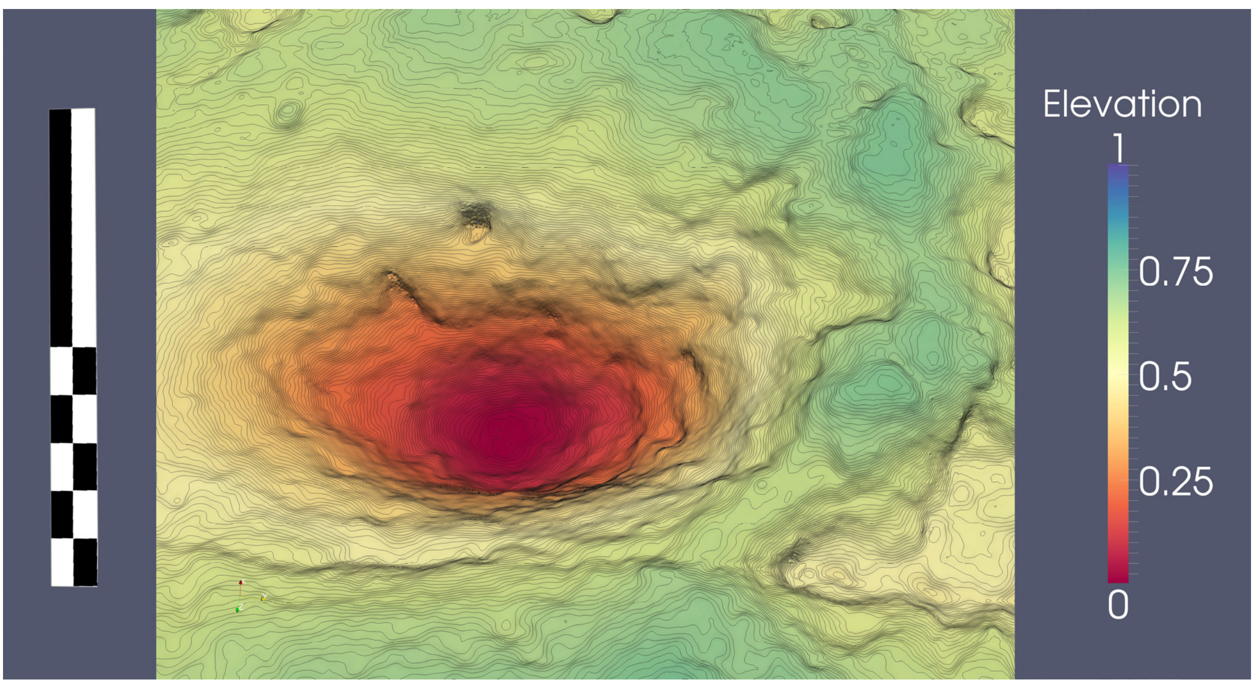

Fig. 7 - Contoured depth map in an oblique western view of the handprint TP_M1 (scale-bar: 10 cm).

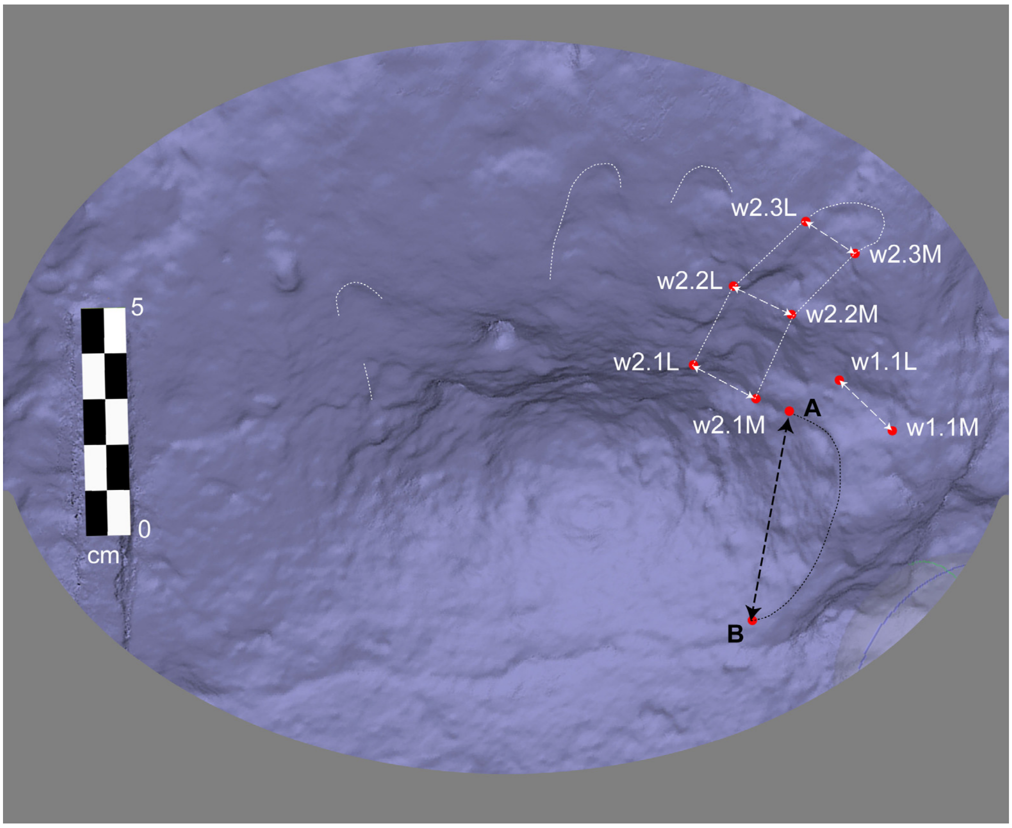

Fig. 8 - 3D model surface with (highlighted) the landmarks for the measurement of the finger widths. There have been also highlighted (dotted lines) the possible forms of the best preserved parts of the fingerprints.

between the edges of the muscle-pad corresponding to the metacarpal I, scaphoid and the trapezoid bones. This distance is ~5,4 cm and can likely match the hand of a present human specimen with a stature ranging from m. 1,50 to m. 1,65. This can also be very easily experimentally established (Fig. 9).

No angle between fingers seems to be precisely and objectively measurable since the hand is flexed in a forced and broken movement, but all the phalangeal longitudinal directions surely converge to the base of the wrist, as it normally happens in the human hand (Garrett, 1971; Navsa, 2010; Vergara et al., 2017).

4. DISCUSSION

As already pointed out, during any consideration about the hand it should be taken into the right account that the human hand is, probably, the limb that has developed the least degree of evolution (Marzke & Shackley, 1986; Aiello & Dean, 1990; McHenry, 1992; Marzke & Marzke, 2000; Almécija et al., 2015). This allows us to affirm that the prehistoric human hand which left its print on the irregularly soft and muddy slope at Tora and Piccilli site was certainly much similar to the present one. This is clearly confirmed by the characteristics of the handprint which show an extremely flexible limb, already enabled to any movement, or system of movements, capable of performing each of the same gestures we do today in our everyday life (Marzke et al., 1986; Jones & Lederman, 2006). And also the dimensional data are fully comparable to the present ones (Garrett, 1971; Navsa, 2010; Vergara et al., 2017). The total length of each finger is not precisely measurable starting from the preserved evidence, because the distal edges are not objectively identifiable and because not all the interphalangeal-joint zones are objectively identifiable.

Fig. 9 - Experimental Photo of the superimposition of present time left hand on the TP_M1 handprint (the hand photographed belongs to a female who is 1,56 m tall).

This is probably due to the fact that the maximum load of the body was put onto the wrist and the carpal zone of the left hand during the forward-medial oriented movement of the total body in the regaining of the lost balance. On the contrary, for the same reason they are very evident and well preserved the proximal and the distal carpal rows. The most remarkable load is also evident on the fingers I and II (Figs. 6, 7, 8, 9).

The dimensional dataset collectible through direct measurements and through 3D modelling of Trackmaker's B hand, as reported in Table 2 and Table 3, do appear fully compatible with those of an actual human hand and fit the preliminarly estimated stature for the Trackmaker B, i.e. ~156 cm (Avanzini et al., 2008). The same data also fall within the range of anthropometric values known both for Pleistocene hominins and present day humans (Mc Henry, 1992; Marzke & Marzke, 2000; Buryanov & Kotiuk, 2010; Garrido Varas & Thompson, 2011; Lorenzo et al., 2015; Darowish et al., 2015; Almécija et al., 2015 and quoted bibliography). Specifically, the dimensions of TP_M1 seem to fit those of a juvenile exemplar (Gaskin et al., 2011; Gilsans & Ratib, 2012) or, more generically, those of a small-sized exemplar of Homo (Panarello et al., 2017b). Moreover, the angular movements of the wrist, do not exceed, respectively, the 15°-40° range for the abduction (radial deviation) and adduction (ulnar deviation), and this also confirms that TP_M1 is actually a human fossil handprint (Ajello & Dean, 1990).

For the explained reasons, an affordable comparison could be done for the Phalangeal proximal length of the index finger only and not in a wide range of cases, but this is actually impossible so far. Indeed, even if findings of hand prints and hand marks are noticed, for different ages, in many scientific publications, very rarely they are accompanied by precise dimensional data and are only mentioned or documented by picture with or without a simple scale-bar. Complete and/or partial handprints and handmarks are known in the Cueva d'El Castillo, Spain (Groenen et al., 2012); at Willandra Lakes, Australia (Webb, 2007); in the Lhasa region, Chinese Tibet (Zhang-Li, 2002; Meyer et al., 2017); in the Grotte de Lascaux, France (Barrière & Sahly, 1964); at Ojo Guareńa, Spain (Ortega, 2009); in the Grotte du Tuc d'Audobert, France (Vallois, 1927; Beguen, 1927a, 1927b; Bahn & Vertut, 1988; Beguen et al., 2009); in the Grotte de Fontanet, France (Clottes, 1973, 1975, 1993; Bahn & Vertut, 1988; Cohen, 2007); in the Grotta della Basura, Italy (Blanc & Pales, 1960; de Lumley & Giacobini, 1985; Rembado & Vicino, 1985; Citton et al., 2017); in the Grotte de l'Aldène, France (Ambert et al., 2007; Galant et al., 2007); in the Grotte de Ganties-Montespan, France (Garcia & Morel, 1995); in the Cueva Temprana, Llanes region, Spain (Lockley et al., 2008; Rodriguez-Asensio & Noval Fonseca, 2012), and elsewhere (Janssens, 1957; Delluc & Delluc, 1985; Guthrie, 2005; Bennett & Morse, 2014; Panarello, 2016). However, like said above, only poor dimensional data can be taken from all these works and they are obtainable only from sometimes and somehow scaled pictures. Nor can be used streaks, scratches and flutings to capture precise dimensions, as most of the other artistic and magic impressions, carvings and pictograms, which are almost completely located in the caves, are strictly linked to the use of fingertips only, or are contaminated by a conscious use of the hands and the fingers, so deforming and/or making unidentifiable any objective dimension of the anatomical parts of the hand.

It also should be taken into the right account that many of the available papers have been published for a long time and/or are quite totally concentrated on the collection, analysis and interpretation of the footprints and/or to the artistic representations, giving very few attentions to the handprints. In this view, also some recent and well-done reports, like the one about the Tibetan Plateau ichnosite (Meyer et al., 2017) gives no space and attention to the dimensions and to the morphology of the found handprints. The Tibetan handprints could have been very precious for a comparison with the Roccamonfina TP_M1 handprint, also for the environmental similarity: both of them, in fact, are preserved in open-air environments. For these reasons, no exhaustive comparison can be done at the present time and for this purpose. In this view, it would be very useful to reanalize all the known ichnosites preserving prehistoric fossil handprints by surveying them with new latest generation instruments and techniques.

5. CONCLUSIONS

The dimensional and morphostructural data, measured from the best preserved fossilised anatomical parts of the handprint TP_M1, and their full compatibility with the available dimensional and morphostructural ranges up to now known for hominins, allow us to to support that very likely the TP_M1 hollow is actually a prehistoric handprint. It was actually printed on an irregularly dry volcanic muddy slope by the left hand of a Middle Pleistocene small hominine, which was habitually biped, during the instinctive movements made to regain the lost balance after a sudden long slide.

Furthermore, the dating of TP_M1 at 349±3 ka (Mietto et al., 2003; Avanzini et al., 2008; Scaillet et al., 2008; Santello et al., 2010) makes it uncomparable, for antiquity, to any other handprint up to now known in the world as none of them is older than 30 ka (Vallois, 1927; Beguen, 1927a, 1927b; Blanc & Pales, 1960; Barrière & Sahly, 1964; Clottes, 1973, 1975, 1993; de Lumley & Giacobini, 1985; Delluc & Delluc, 1985; Rembado & Vicino, 1985; Bahn & Vertut, 1988; Garcia & Morel, 1995; Zhang-Li, 2002; Guthrie, 2005; Ambert et al., 2007; Cohen, 2007; Galant et al., 2007; Webb, 2007; Lockley et al., 2008; Beguen et al., 2009; Ortega, 2009; Groenen et al., 2012; Rodriguez-Asensio & Noval Fonseca, 2012; Bennett & Morse, 2014; Panarello, 2016; Citton et al., 2017; Meyer et al., 2017).

This evidence allows us to affirm that the TP_M1 may be considered as the oldest confirmed human fossil handprint known in the world so far. It is not comparable at this time with any other similar ones located both in sub-aerial and hypogeal environments. Moreover, just like noted in the preliminary studies (Avanzini et al., 2008), the handprint TP_M1 is completely free from any cultural and magic needs, so that it can only be evaluated and analysed in a dynamic point of view by linking it to the trackmaker's pace.

The great paleontological and mainly behavioral value of the handprint TP_M1, which was already intuited at the moment of its find (Mietto et al., 2003; Avanzini et al., 2008), is now confirmed by instrumental tests and re-launched with the addition of an anatomical/dimensional dataset, which could reveal precious for the study of similar evidence and contexts.

Being the result of an instinctive and absolutely not premeditated action, the TP_M1 handprints is a rare capture of a moment of Middle Pleistocene everyday life. In this way it can be also considered as a sort of quite one-of-a-kind photographic snapshot taken at any moment in a farthest past.

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