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# Comments on possible Miocene hominin footprints

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ABSTRACT

Gierlinski et al. (2017) report on what they interpret to be Miocene hominin footprints near the seaside village of Trachilos in western Crete. We review the case made by the authors that these ichnites represent bona-fide footprints, and their conclusion that they were made by bipedal hominins. Gierlinski et al.'s study demonstrates a number of problems with data presentation, e.g. a) substrates corresponding to measured prints are not clearly specified, b) no explanation is given for how prints were identified when the authors' own criteria for print identification were not met, c) no consistent morphological detail among prints is provided that could identify them as originating from the same or a similar agent, or one with bilateral symmetry, d) alternative agents that could have produced the prints are not explored, e) no explanation is given as to how their multivariate analyses of print outlines deals with missing data and why it uses non-homologous landmarks, etc. The evidence they present, therefore, is insufficient to support their arguments and conclusions. We remain unconvinced the ichnites are bona-fide footprints, let alone hominin footprints, but discuss some of the criteria employed for distinguishing and recognizing an early hominin footprint.



Gierlinski et al. (2017) report on possible hominin footprints in a layer of well-lithified calcareous sand belonging to the Roka formation, a local deposit of the Vrysses group, near the seaside village of Trachilos in western Crete. Considering the imprinted layer represents a shallow marine deposit (cannot be confused with the deep-water marlstones of the Zanclean stage), lacks foraminera indexing post-Miocene deposits, and has a stratigraphic sequence very proximal to but underlying the base of the Hellenikon group (a terrestrial deposit associated with the Messinian Salinity Crisis dated at 5.6 Ma), the authors provide a probable age of 5.7 Ma for the reported footprints with an age range of 8.5–5.6 Ma.

## 1. Footprints, or not?

Notwithstanding questions as to its hominin vs. non-hominin status, it must first be established whether or not these ichnites are indeed bona-fide footprints. According to the authors, the prints consist of 42 sediment-filled impressions devoid of anatomical detail, running in a SSW-NNE direction on surface A. More than 50 additional ichnofossils, including markings of unknown origin, were found on surface B2. The authors, however, do not indicate which of the two surfaces (A or B2) the prints they measure and report on in detail come from, complicating interpretations of their arguments. A histogram (Fig. 2d in Gierlinski et al. 2017) shows a total of 28 out of 41 ichnites (~68%) were confidently identified as footprints. An orientation rose (Fig. 2e in Gierlinski et al.) shows 17 out of these 28 identified footprints (~60%) have the described SSW-NNE directional alignment. It remains unclear whether the sample in the histogram or the orientation rose, or the 10 ichnites in the morphometric analysis depicted in their Fig. 13, are from surface A or B2.

The authors offer various criteria for identifying bona-fide footprints from among the ichnites, i.e., impressed state with expulsion rims, pull-up features, morphological detail, consistent outlines, and consistent variation in size. A weak case, however, is made for consistent, bi-laterally symmetrical impressions resulting from a vertebrate, let alone a hominin. No consideration is offered for other potential agents, biological or otherwise (e.g. waves, wind, rain, frost, animal burrows, imprints of vegetative matter, colony growth, etc.). Indeed, the "three most well-preserved footprints" (Gierlinski et al. 2017, pg. 9) depicted in their Fig. 9., do not consistently exhibit the features Gierlinski et al. note they use to identify footprints. Consequently, it is not known to what extent any of the other so-identified footprints exhibit any

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combination of the identifying features. Since the three most well-preserved footprints are of three distinct sizes, they offer no evidence of detail repetition within same-sized footprints. One of the three most well-preserved prints, interpreted with color-coded topography, does not appear to hold up to closer scrutiny in the laser-scanned transverse sections depicted in Gierlinski et al.'s Fig. 10, i.e. the transverse sections figured on the right do not appear to be scaled with each other, or with the accompanying footprint so that the successive sections do not align with each other or with the corresponding locations labeled on the footprint. Nor do the three "less well-preserved" footprints in their Fig. 11 provide any assurance as to the authors' reliability in identifying the additional non-figured ichnites as "footprints."

Assertions of consistency in morphological detail are based on Gierlinski et al.'s (2017) claims that the same morphologies are repeated from imprint to imprint. As examples of such detail, the authors point to impressions they interpret to be the ball (hallucal-metatarsaophalangeal joint) and distal pad of a hominin big toe (hallux). There is, however, no consistency in the appearance of said "ball" among the three most well-preserved examples illustrated in their Fig. 9. The most prominent such feature, indicated in their Fig. 9b, is from a presumed footprint with only four laterally directed digits, curiously with no apparent space to accommodate a fifth. In fact, Gierlinski et al. do not figure any prints that among them show consistent features – either heel, ball, or digits.

Regarding their comparative morphometric analysis, the "three most well-preserved footprints" figured (Gierlinski et al. Fig. 9) do not clearly show the 11 landmarks supposedly taken from 10 Trachilos footprint outlines, raising questions over how landmarks were identified on the remaining non-figured 7 prints making up the total sample. Use of footprints missing some of the 11 landmarks together with the fact that landmark 9 (their Fig. 13) is not homologous in prints with adducted halluces (most medial point on the 1st metarsophalangeal joint) vs those with abducted halluces (most medial point on the 2nd metatarsophalangeal joint), undermines their morphometric comparison. Without clear landmarks, it may be their preconception of a hominin footprint that guides them as to where to place the missing landmarks, not the print morphology itself.

Gierlinski et al.'s (2017) asserted examples of expulsion rims are quite varied, more so than is to be expected for a repetitive action like a bipedal gait. Although their text discusses pull-out features, due to the assumed "sticky" nature of the calcareous sand substrate, no clear examples are figured to illustrate these stated artifacts. The "three most well preserved prints" illustrated have in-filled sediment or adhering overlying sediment, but no pull-up features. The second transverse section from the top, in their Fig. 10, is the only place the authors label a pull-up feature. In this same section, however, this pull-up feature is also labeled as a pressure release ridge. Pull-up features and pressure release ridges, however, are two very different artifacts resulting from diametrically opposite forces (tension vs compression). In their Fig. 9b this same feature is indicated to be adhering overlying sediment – yet a third interpretation. Which of the three is it? Furthermore, it is problematic that the outline of the print and not the relief features of the print interior are described as best preserved. Incumbent to this assertion is an explanation as to how "moist slightly sticky calcareous sand" functions to obliterate the interior of the print but not its outline. Preferably, the authors could figure examples illustrating this phenomenon.

In spite of considerable size variation, ranging from 94 to 223 mm, the authors state, "the tracks are of similar size and have consistent outlines across all specimens." Of the 28 prints that they confidently identify as such, 17 (~61%) are less than 150 mm in length (their Fig. 7c) and of those, 5 (~18% of total sample) are less

**Fig. 1.** Outline of the footprint of a rock hyrax *Procavia capensis*, with length ranging between 65–76 mm.

than 100 mm (their Fig. 7b). This would be notably small for a hominin foot. By comparison, the smaller G1 footprints at Laetoli (*Praehominipes laetoliensis*) measure ~180 mm long. The nearly complete foot skeleton of *Homo naledi*, which is comparable to the smaller Laetoli prints in size (~164 mm) is also much larger than a majority of Trachilos prints.

The size of some of the Trachilos prints brings to mind the prints of the four-toed clawless forefoot or three-toed clawless hindfoot of a hyrax (Fig. 1; cf. their Fig. 8), a mammal which up to the Pliocene was wide-spread throughout Europe, Africa and Asia, a possibility not considered by Gierlinski et al.

Illustrating the most well-preserved prints to the same absolute length, even with a scale provided, might potentially underplay the degree of variation in the size of the ichnites, which is all the more dramatic when all three prints are depicted to scale (Figs. 2 and 3).

Unlike the Laetoli hominin footprints, the Trachilos B2 ichnites present no obvious trackways. The two examples offered in their Fig. 2 appear questionable, easily lost in the jumble of ichnites on that surface, a caveat openly acknowledged by the authors. Both alleged B2 tracklines exhibit markedly varied step length (Gierlinski et al. Fig. 7b, c). They indicate at best, tottering or ambling steps, but not a striding gait. Moreover, it is not clear if the inferred tracklines are comprised of a series of comparably-sized footprints. The authors claim that the print sizes vary considerably due to variability in preservation. What is not clear is whether some prints are small because they are incomplete, or some larger due to overprinting. Because the Trachilos ichnites do not present a long trackway comprising an extended series of repeated prints, it is incumbent on the authors to show there is repetition of print. Without this demonstration, their argument for bona-fide footprints finds meager, if any, support.

## 2. Hominin footprints, or not?

Given the lack of compelling evidence that the ichnites are bona-fide footprints, it is perhaps moot to evaluate the arguments for and against hominin status. However, a review of the criteria Gierlinski et al. employ is worthwhile. The assertion of bipedal gait, combined with an entaxonic foot (i.e., the long axis of the foot shifted medially, often with an enlarged medial digit, see Fig. 4), and an adducted hallux seem to be the principal factors in the

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