Stinging News: '*Dickinsonia*' discovered in the Upper Vindhyan of India Not Worth the Buzz

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Abstract:

A recent report of *Dickinsonia tenuis* 'hiding in plain sight' at the Bhimbetka rock shelters in rocks of the Maihar sandstone (Upper Vindhyan) has important implications for paleogeography and the age of the Upper Vindhyan. We visited the site in December 2022 and found the evidence for *Dickisonia* lacking. The 'fossil' resembles decayed parts of modern *Apis dorsata* (giant honeybees) hives. In this contribution, we note the structural similarities between "*Dickinsonia*" and honey and pollen stores of decaying bee nests. A closer view of the photos provided in the original paper reveals honeycombed structures within the purported fossil. We also note that the fossil is not located on a bedding surface and is not a part of the rock, but rather is attached as a 'tracery of waxy material' above the surface. The remaining paleogeographic conclusions of that paper are also negated by this new discovery.

1. Introduction

The Vindhyan Basin is in north-central India and is the largest of several "Purana" (=ancient) sedimentary basins in Peninsular India. The basin covers more than 1.6 million square kilometers with a total estimated sedimentary thickness of ~5000 meters (figure 1). The basin contains two distinct sedimentary sequences separated by an angular unconformity. Numerous U-Pb ages on interbedded ash units constrain the depositional history of the Lower Vindhyan to between ~1800-1600 Ma (Ray et al., 2002, 2003; Rasmussen et al., 2002). The age of the Upper Vindhyan Kaimur, Rewa and Bhander sequences is controversial (De, 2003; De, 2006; Kumar, 2012, 2016; Meert and Pandit, 2015; Basu and Bickford, 2015). The lowermost Kaimur sandstone is intruded by the 1073 Ma Majhgawan kimberlite (Gregory et al., 2006) indicating that subsidence likely began in the Stenian . A less well-defined Re-Os age of 1210 +/- 52 Ma was obtained from the black shales within the upper part of the Kaimur (Tripathy and Singh, 2015). The Rewa sandstone rests conformably on the Kaimur and contains traces of diamond likely sourced from the Majhgawan kimberlite making it younger than 1073 Ma (Kumar, 2016). There are no reliable ages from the Bhander Formation although there are several attempts to date interbedded limestones using U-Pb methods (Gopalan et al., 2013). These ages range from 866-1073 Ma with large errors. All are consistent with a proposed closure age for the Upper Vindhyan ~1000 Ma (Malone et al., 2008).

2. Faunal Evidence for the age of the Upper Vindhyan

Within the Son Valley sector, two sedimentary packages lie above the Bhander limestone known as the Sirbu shale and Maihar sandstone. Kumar (2016) argued that these two units may be considerably younger based on fossil findings of *Arumberia banksi* and *Beltanelliformis minutae* (Kumar and Pandey, 2008). The latter fossil was recently categorized as cyanobacteria (Bobrovskiy et al., 2018). The nature of the enigmatic fossil/structure of *Arumberia banksi* is controversial with various authors suggesting that it is a sedimentary structure or organic-sedimentary structure (McIlroy and Walter, 1997; Jensen et al., 2005; Becker-Kerber et al., 2020) whilst others argue for a biological origin (McMahon et al., 2021; Retallack and Broz, 2021). McMahon et al. (2021) argue that *Arumberia* is restricted to the 560-520 Ma interval; however older *Arumberia* occurrences are known from Baltica (573 Ma; Razumovsky et al., 2021) and Scotland (~1.0 Ga; Callow et al., 2011). The recent report of *Dickinsonia tenuis* from the Maihar sandstone near Bhopal is a potentially critical time marker due to its limited range and identity as an animal fossil (Bobrovskiy et al., 2018; Retallack et al., 2021).

3. Other Age Constraints on the Upper Vindhyan

Detrital zircon studies from the Upper Vindhyan show a unique pattern with a lack of zircons younger than 1.0 Ga (Malone et al., 2008; McKenzie et al., 2011; Turner et al., 2014). This age distribution was confirmed recently for the Maihar sandstone (Lan et al., 2021); however, an earlier publication (Lan et al., 2020) yielded a single zircon age of 548 Ma from the same unit. The 548 Ma age was used by the authors to assert that Vindhyan sedimentation continued well into the Ediacaran. This youngest age would be consistent with the presence of *Dickinsonia* in the Maihar sandstone.

Malone et al. (2008) argued that the similarity between paleomagnetic data from the Rewa-Bhander sandstones and limestones overlapped with directional data from the 1073 Ma Majhgawan kimberlite (Gregory et al., 2006). They further argued that the similarity between the paleomagnetic poles along with the lack of detrital zircons <1000 Ma indicated that basin closure took place in the early Tonian. Subsequent paleomagnetic work on the 1.1 Ga Great Dyke of Mahoba yielded similar results with Bhander-Rewa and Majhgawan lending further support to the hypothesis that Upper Vindhyan sedimentation ceased around 1.0 Ga (Pradhan et al., 2012). Meert and Pandit (2015) argued that basin closure resulted from collision of the Northern Indian Block (NIB) with the South Indian Block (SIB) along the Central Indian

Tectonic Zone (CITZ) at around 1.0 Ga (Bhowmik, 2019). Collisional orogenesis also took place in the Aravalli-Delhi region during the Tonian-Cryogenian interval (900-680 Ma; Singh et al., 2021).

4. *Dickinsonia tenuis* or *Apis dorsata?*

In a landmark study, Bobrovskiy et al. (2018) demonstrated that *Dickinsonia* represents one of the oldest animals on Earth. The presence of this fossil in the Maihar sandstone would therefore end discussion on the age of the Upper Bhander sequence and place it squarely in the Ediacaran Period. The finding would also suggest that paleomagnetic data from the Bhander-Rewa is of the same age or, alternatively, was remagnetized sometime after deposition. Due to the relatively undisturbed nature of the Vindhyan sediments, there is no field test demonstrating the primary nature of the remanence. Malone et al. (2008) argued for a likely primary remanence based on the presence of stata-bound magnetic reversals, which is suggestive, but not conclusive of a primary remanence (Meert et al., 2020).

Retallack et al. (2021) reported finding Dickinsonia 'hiding in plain sight' at the Bhimbetka rock shelters just south of Bhopal India (a UNESCO heritage site; Figure 2).

We argue that the report of an isolated occurrence of *Dickinsonia* at Bhimbetka is a case of mistaken identity. The shapes, forms and mode of occurrence are not consistent with other occurrences of *Dickinsonia*. Moreover, we note the presence of myriad giant honeybee hives (Figure 3) within the rock crevices that show remarkable similarities to the purported fossil of *Dickinsonia* described by Retallack et al. (2021). Based on the following observations, we reject the finding and offer an alternative, albeit mundane explanation for the apparent isolated *Dickinsonia* fossil:

(1) *Beehive activity*- Retallack et al. (2021) argued that high-resolution photos of the fossil demonstrate a morphology like *Dickinsonia*. On arrival, we noticed that the rocks at Bhimbetka were replete with giant honeybee nests (*Apis dorsata)*. The nests resided under ledges in the jointed/broken Maihar sandstone and ranged in size from 0.25-0.5 m in length or diameter (figure 3). These sizes are estimates because most were located 10-20 meters or more above ground level. Hive shapes were oval or lenticular. Most of the

hives show a dark staining around the hive that could easily be mistaken for soot (figure 3-yellow star).

(2) *The 'fossil' is not located on a bedding plane*- The Maihar sandstone at Bhimbetka is dipping shallowly to the NE (Strike: 300; Dip: 8; Figure 2a). The bedding can be readily observed in Figure 2b. The most common mode of preservation for Dickinsonia is as negative relief impression on the base of sandstone beds (Gehling, 1999; Tarhan et al., 2016). The archway on which the fossil was located represents a fracture/joint along which part of the overlying material collapsed to form the cave/shelter. A photo taken sub-parallel to essentially flat-lying bedding (even taken below the fossil) therefore would not reveal much of the fossil. The photo in Figure 2c shows a full view of the fossil indicating that the impression is located on a tilted fracture surface and therefore at an angle to bedding.

(3) Rapid decay of the fossil: Figure 4a shows the image used in Retallack et al. (2021) which was taken in early 2019 alongside our image taken Dec 3, 2022 (Figure 4b). Much of the central part of *Dickinsonia* is now gone. The discovery team argued in news reports (https://www.theweek.in/theweek/specials/2021/02/19/return-of-the-past.html) that soot from the Neolithic fires was causing the decay. A more parsimonious explanation is that the organic material produced by the honeybees is susceptible to decay over a relatively short time interval. We enlarged a portion of the downloadable high-resolution image in Retallack et al. (2021) where a honeycomb structure (characteristic of honeybees is highlighted; Figure 4c).

(4) *The fossil is not flat-lying*- There is a crack located in the upper-right hand corner of the fossil (figure 4a). The crack contains a few small wasp or bee hives. While not obvious in our pictures (or those in Retallack et al., 2021), the fossil wraps around a slightly curved surface into the crack rather than resting on a planar surface. Hive structures can wrap up curved or even vertical surfaces as illustrated in figure 5). Giant honeybee nests can grow at any angle including vertically.

(5) *Beeswax, propolis and honey/pollen stores*- We found an abandoned and decaying hive located 15-20 m above ground-level near the auditorium entrance. This photo shows various parts of the hive including the relict hive (red, Figure 5a), the honeycombed inner nest structure (green) and the waxy honey-pollen store attachment to the rock surface

(blue). Propolis is sticky, brown-colored material composed of a mix of beeswax, saliva and plant resins used as 'glue' to repair and give integrity to the hive (Bankova et al., 2000; Rajput et al., 2022). Propolis may be responsible for the dark staining around abandoned nest sites (Figures 5a, 3c). Beeswax is used to construct the hive resulting in a characteristic honeycomb shape. Note that the shape of the honey and pollen store in Figure 5b closely resembles the *Dickinsonia* described in Retallack et al. (2021). In Figure 5b, the 'Dickinsonia-like' shape is also attached both the underside of the outcrop and wraps around a nearly vertical surface (yellow star-underside; blue star-vertical). A modern honey and pollen store is shown in Figure 5c (Neupane et al., 2016). The honey and pollen store neatly explains the '*tracery of white waxy material*' noted in the Retallack et al. (2021) manuscript.

(6) The 'fossil' is not part of the rock, but is a surficial feature raised above the rock surface (see figure 6-a,b,c). The decaying beeswax can be seen as filamentous white material in the close-up images.

(7) *Isolated occurrence*- If this were *Dickinsonia*, it would be the only observation of *Dickinsonia* within the Upper Vindhyan. We spent two days in the field looking at other outcrops in the immediate area (and around Bhopal) without success. We admit the absence of evidence is not evidence of absence, but given the remaining evidence cited in this paper, we argue that an Ediacaran age based on the alleged discovery of *Dickinsonia* is not supported at this time.

Conclusions

Dickinsonia tenuis was reported in the Maihar sandstone at the Bhimbetka Shelters near Bhopal India. A closer look demonstrates that the impression resulted from decay of a modern beehive which was attached to a fractured rock surface. The age of the Upper Vindhyan therefore remains contested and the proposed paleogeographic reconstruction made in the Retallack et al. (2021) paper is not supported.

Acknowledgements: We followed best ethical practices at the UNESCO site. Our samples consisted solely of photographs and the only measurements were Brunton-based strike and dip measurements. The authors would like to thank Dr. Cameron Jack (University of Florida Institute for Agricultural and Food Sciences) for his helpful advice on the nesting structures of Asian honeybees. This research was supported by a grant from the US National Science Foundation to JGM (EAR18-50398).

Figure Legends

Figure 1: Generalized geological map of the Son Valley area of Vindhyan Basin and other tectonic/geological elements on the Northern Indian Block. Bhopal inlier hosts the Bhimbetka Natural rock shelters (red square). Map after Bose et al., 2015.

Figure 2: Map of the UNESCO Heritage site at the Bhimbetka rocks shelters south of Bhopal, India after Bednarik (2019). Strike/dip symbols shown on Auditorium shelter. (b) Auditoriumm cave entrance photo looking west (~270). Red arrow points to "Dickinsonia". Inset: Enlarged view of the fossil located along a fracture.

Figure 3: Photos of active/decaying hives at the Bhimbetka site (a) red arrows point to active lenticular-shaped hives some 15-20 meters above the amphitheater floor; (b) red arrows active hives, blue arrows decaying hive, yellow arrow hive central support structure surrounded by 'ghost' sooty material outlining the main hive; (c) enlarged waxy central support structure.

Figure 4: Rapid decay of "*Dickinsonia*"; (a) photo from Retallack et al. (2021) taken in early 2019; (b) Photo taken by the current authors Dec 3, 2022 (c) enlarged photo from 4a showing honeycomb structures consistent with a bee origin.

Figure 5: (a) Partially decayed honeybee nest at Bhimbetka showing remaining hive (red); honeycomb structure (green) and honey and pollen store (blue). The blue region has a shape resembling 'Dickinsonia' in figure 4a. Honeybee hives leave a dark residue which might be confused with soot from 'Neolithic' fires (as described by the Retallack et al. (2021) in various news reports…https://www.theweek.in/theweek/specials/2021/02/19/return-of-the-past.html). (c) Honey and pollen store removed from a nest of *Apis dorsata* (Neupane et al., 2013).

Figure 6: (a) The complete '*Dickinsonia*" fossil shown in a Dec 3, 2022 photo (Iphone Pro Max 77 mm, f=2.8); (b) Zoomed photo showing raised 'wax' structures attached to the rock surface rather than part of the rock surface; (c) further zoomed image of the surficial wax structures (white). Note some have slightly elongated honeycomb structures (compare to figure 4c)

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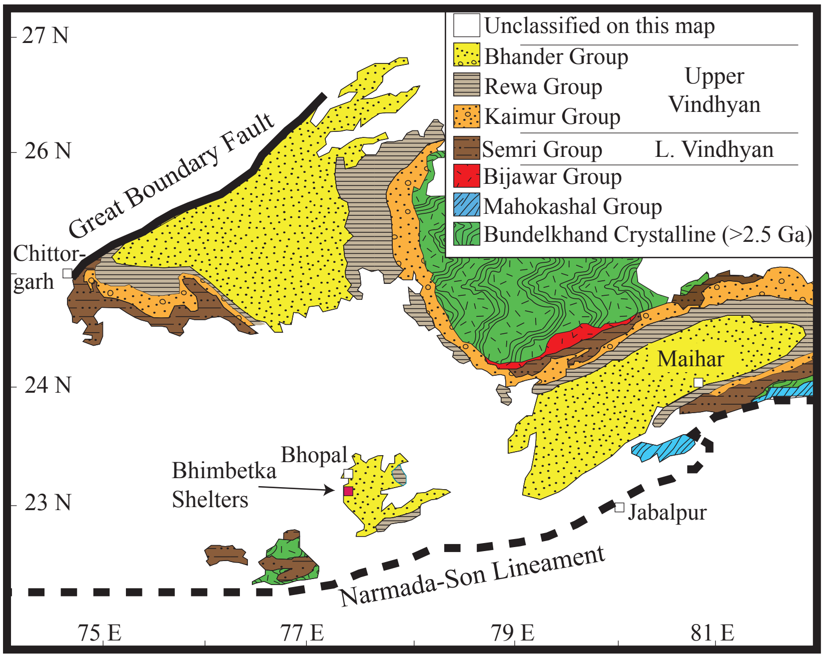

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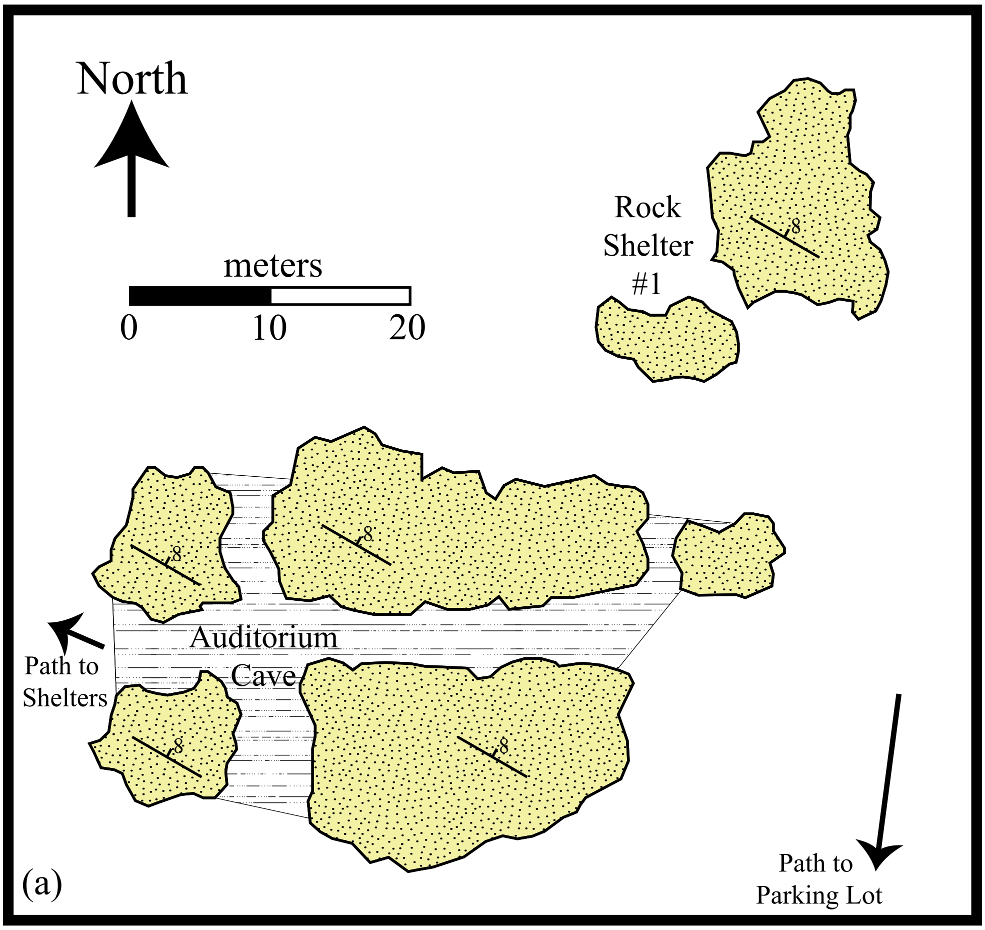
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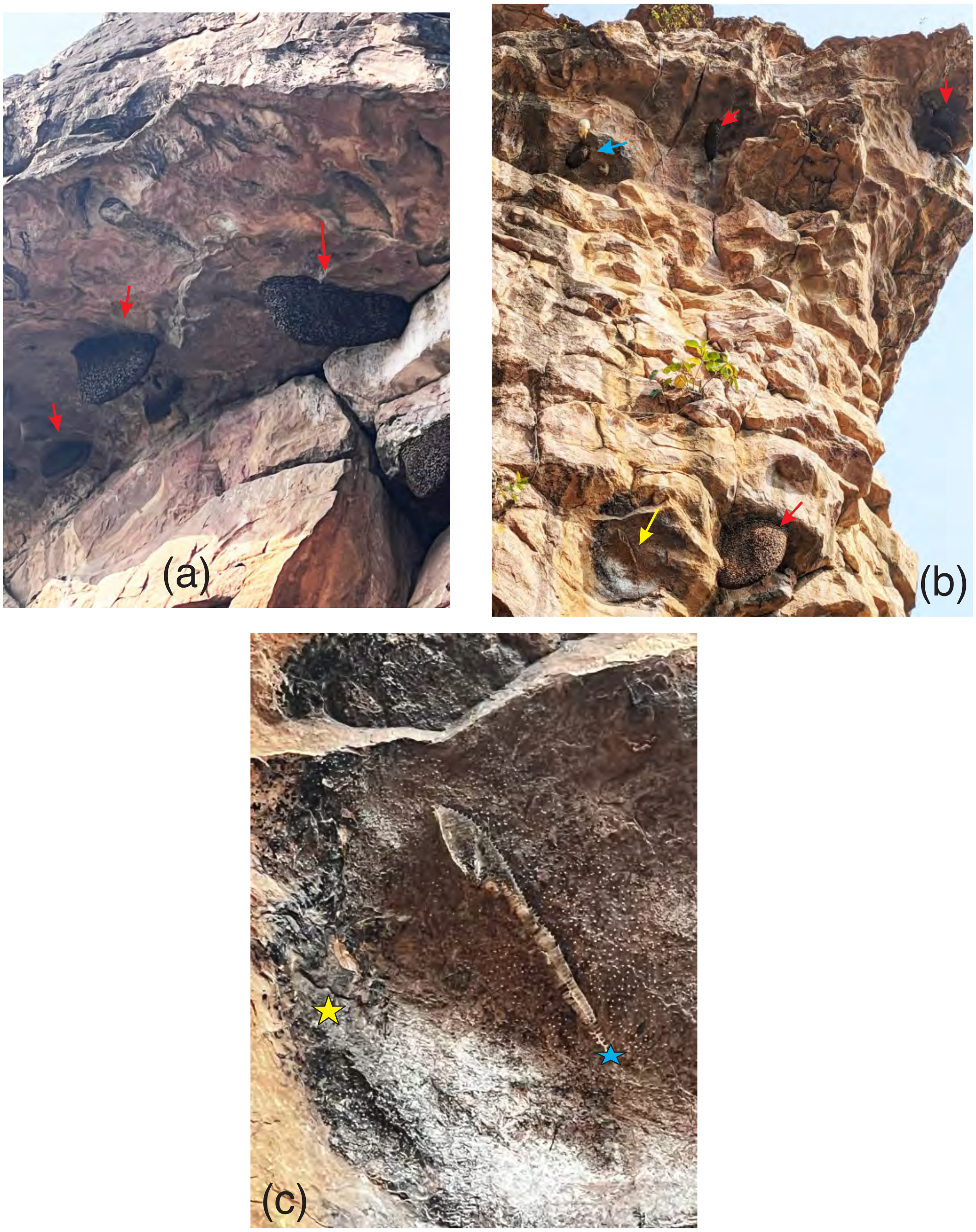
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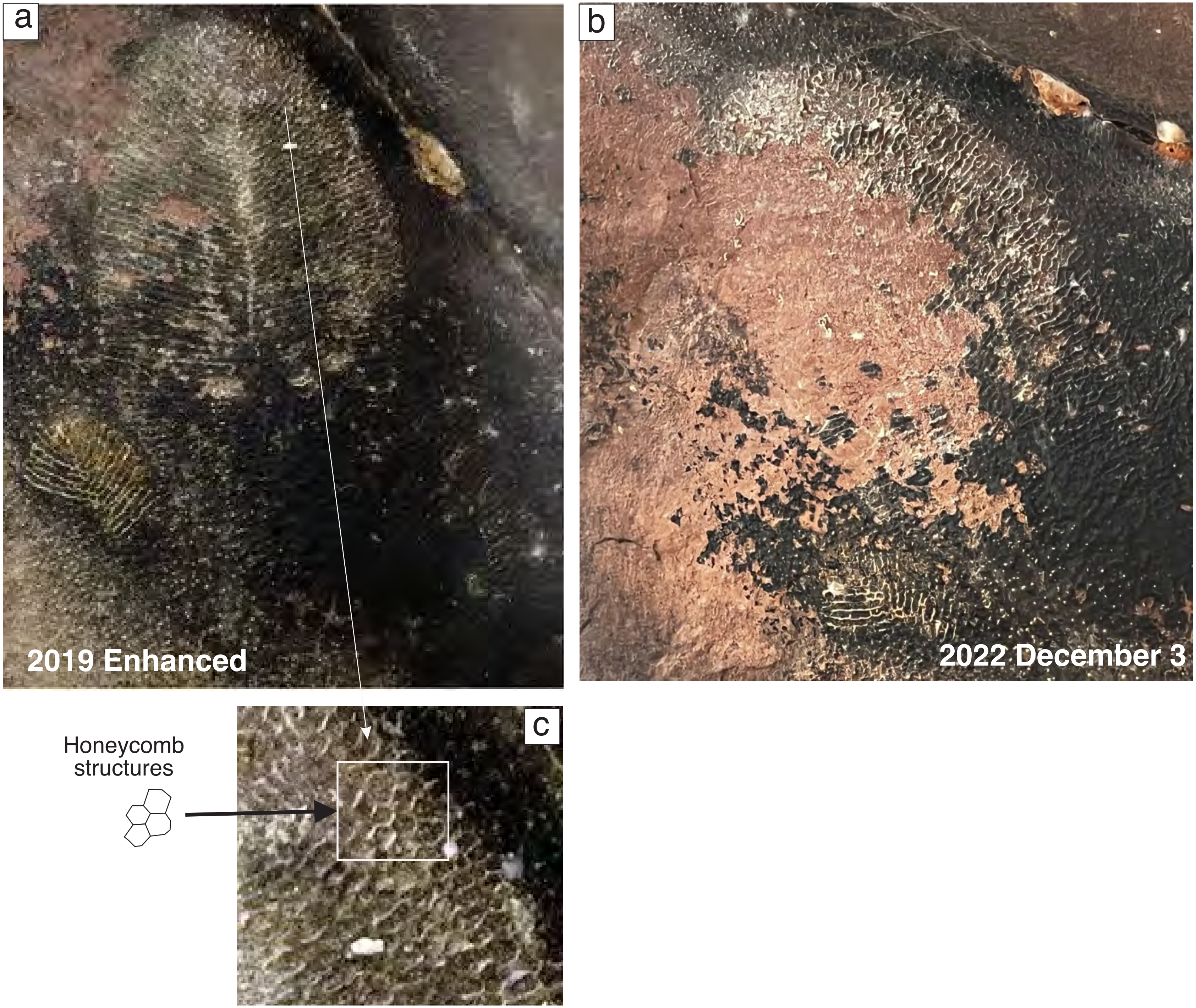

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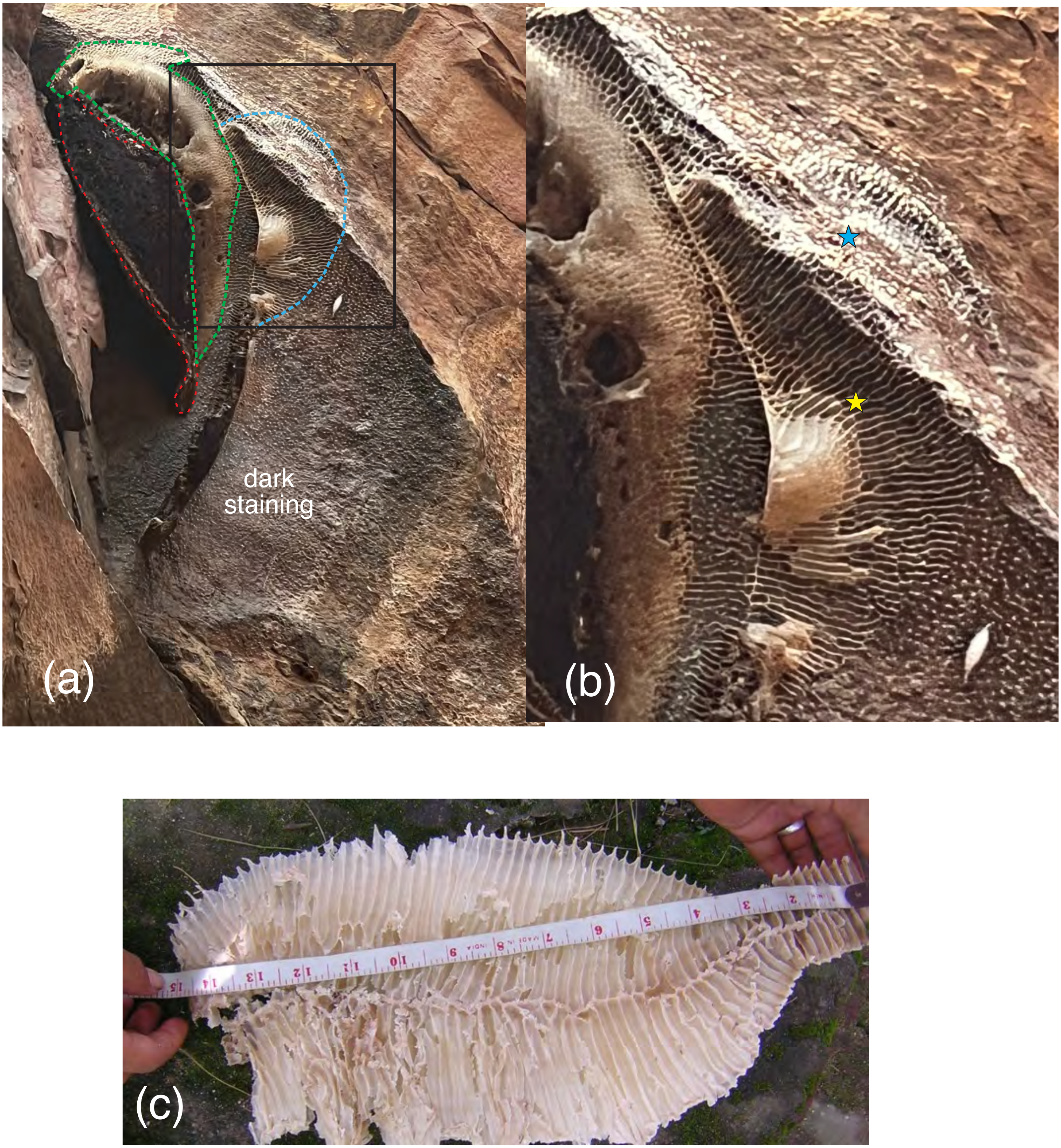

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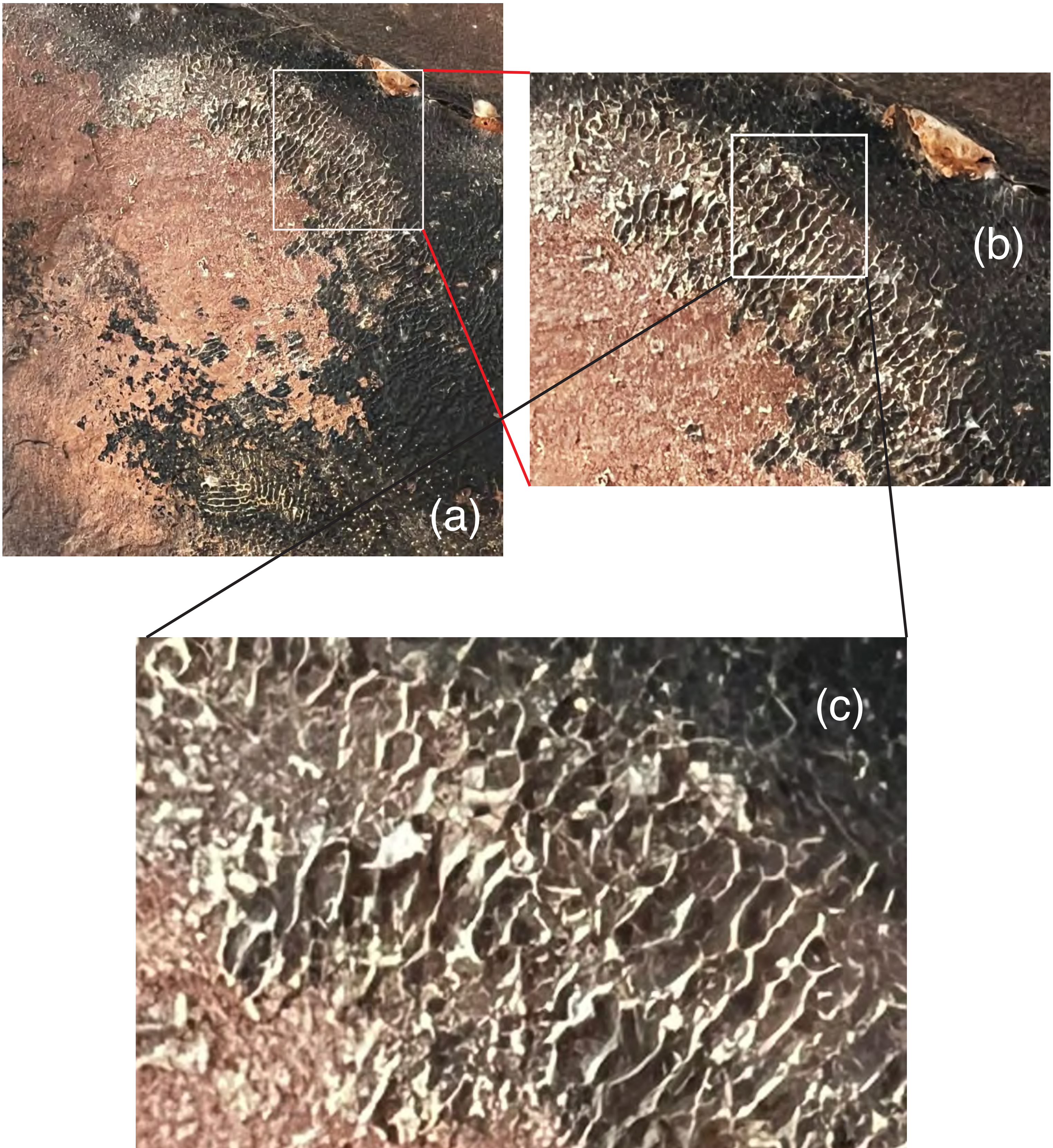
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