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Amberground serpulid polychaetes on mid-Cretaceous Burmese amber

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Abstract

The mid-Cretaceous Burmese (Kachin) amber is renowned for its diverse inclusions and the insights they provide into ancient biodiversity. Several amberground marine animals have been hitherto reported. Here, we document a new amberground discovery: polychaete dwelling tubes, suggesting a coastal environment inhabited by multiple serpulid species. This finding provides further insights into the depositional palaeoenvironment and palaeoecology of the Burmese amber.

Keywords: Serpulidae, tube-dwelling polychaetes, palaeoenvironment, palaeoecology

Introduction

Amber from Myanmar has been known in Asia for over 2,000 years (Zherikhin & Ross, 2000). Burmese amber is an essential resource for understanding the diverse range of plant and animal inclusions, encompassing bryophytes, ferns, gymnosperms, angiosperms, fungi, molluscs, onychophorans, vertebrates, nematodes, and a wide variety of arthropods (Ross, 2019, 2024). To date, the amber from northern Myanmar has yielded an abundance of taxa, including 50 classes, 133 orders, 726 families, 1,757 genera, and 2,770 species (excluding trace fossils and marine encrusters; Ross, 2024). Numerous amberground marine animals have also been recorded from mid-Cretaceous Burmese amber, indicating a coastal palaeoenvironment for its deposition. These marine animals include molluscs (pholadids and oysters), corals, and crinoids (Mao *et al.*, 2018). Here, we report a new discovery of serpulid polychaete dwelling tubes, adding another example of amberground marine animals in Burmese amber.

Material and methods

This study is based on eight specimens from mid-Cretaceous Burmese amber, recently examined. The amber material originates from a locality near Noije Bum (26°20’ N, 96°36’ E), Hukawng Valley, Kachin State, northern Myanmar. All studied material is housed at the Nanjing Institute of Geology and Palaeontology, Chinese Academy of Sciences (NIGPAS), Nanjing, China. The photos of recent serpulid tubes were taken from the Andaman Sea area, Krabi, Thailand by DYH (Fig. 3).

Photographs were taken using a Zeiss Axio Zoom V16 stereo microscope and a Zeiss Axio Imager 2 light microscope with a digital camera attached. Microtomographic data were obtained with a Zeiss Xradia 520 Versa 3D X-ray microscope at the micro-CT laboratory of NIGPS and analysed in VGStudioMax 3.0.

Results

The tube-dwelling polychaetes identified so far can be classified into two categories, both preserved as isolated calcareous tubes in three dimensions. The first type features irregularly curved tubes with convolutions and sharp turns (Figs 1A–C, 2A–C). These tubes can reach a length of up to 2 cm, with diameters ranging from less than 0.2 mm to just over 0.7 mm. The width gradually increases along the length of the tube, with a slightly expanded base for substrate attachment. These tubes have longitudinally parallel keels (Figs 1A, 2A), with 3–7 prominent keels extending the entire length of the tube. This morphology resembles that of the extant genus *Protula*. The second type of tube is coiled and relatively large, with a consistent diameter. Its dorsal surface is equipped with prominent

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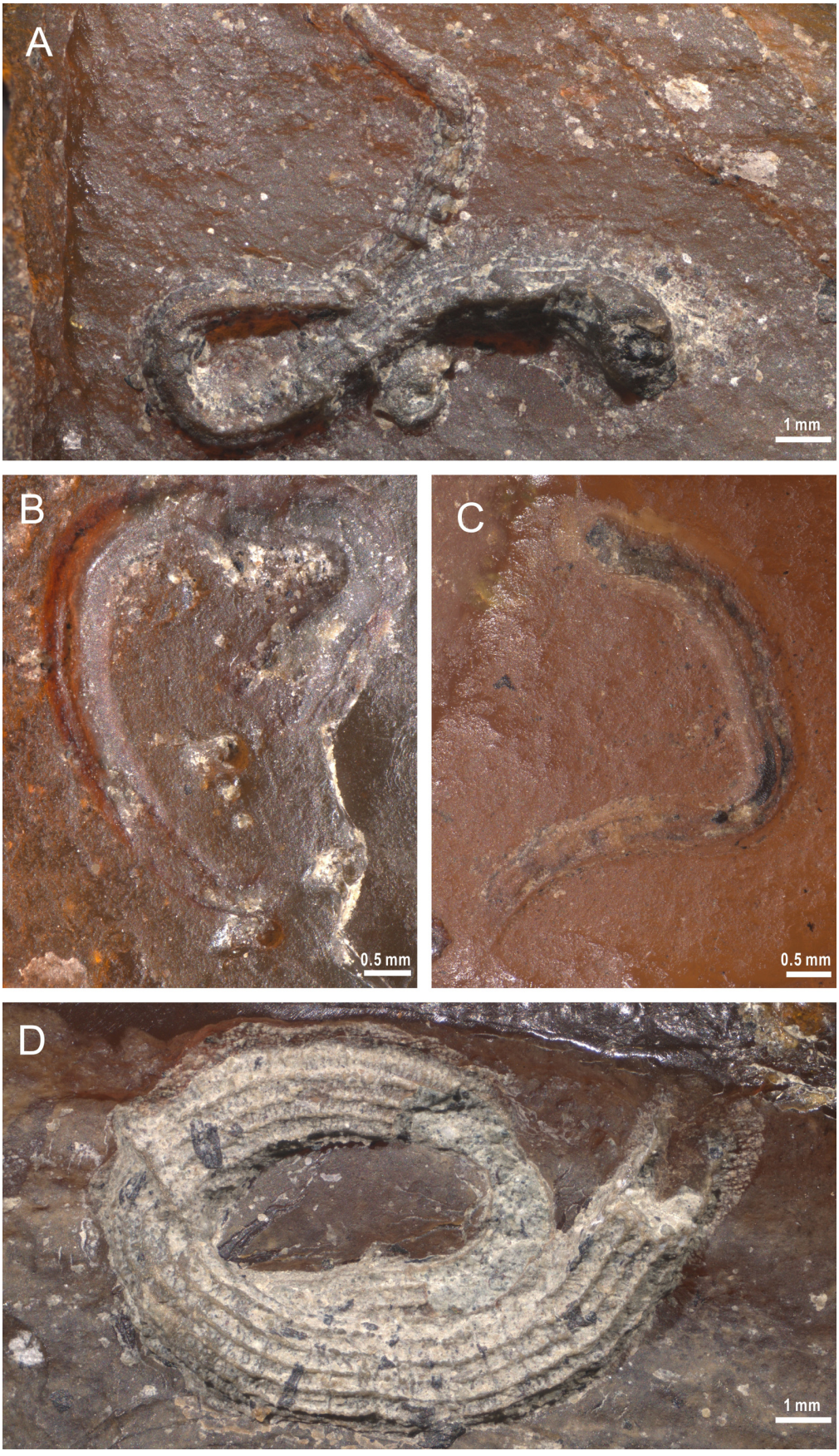

FIGURE 1. Serpulid tubes on the surface of Burmese amber. **A**, Twisted tube with visible parallel keels, NIGP205641. **B**, Twisted tube steinkern, NIGP205642. **C**, Curved tube with parallel keels, NIGP205643. **D**, A relatively large, coiled form, NIGP205644.

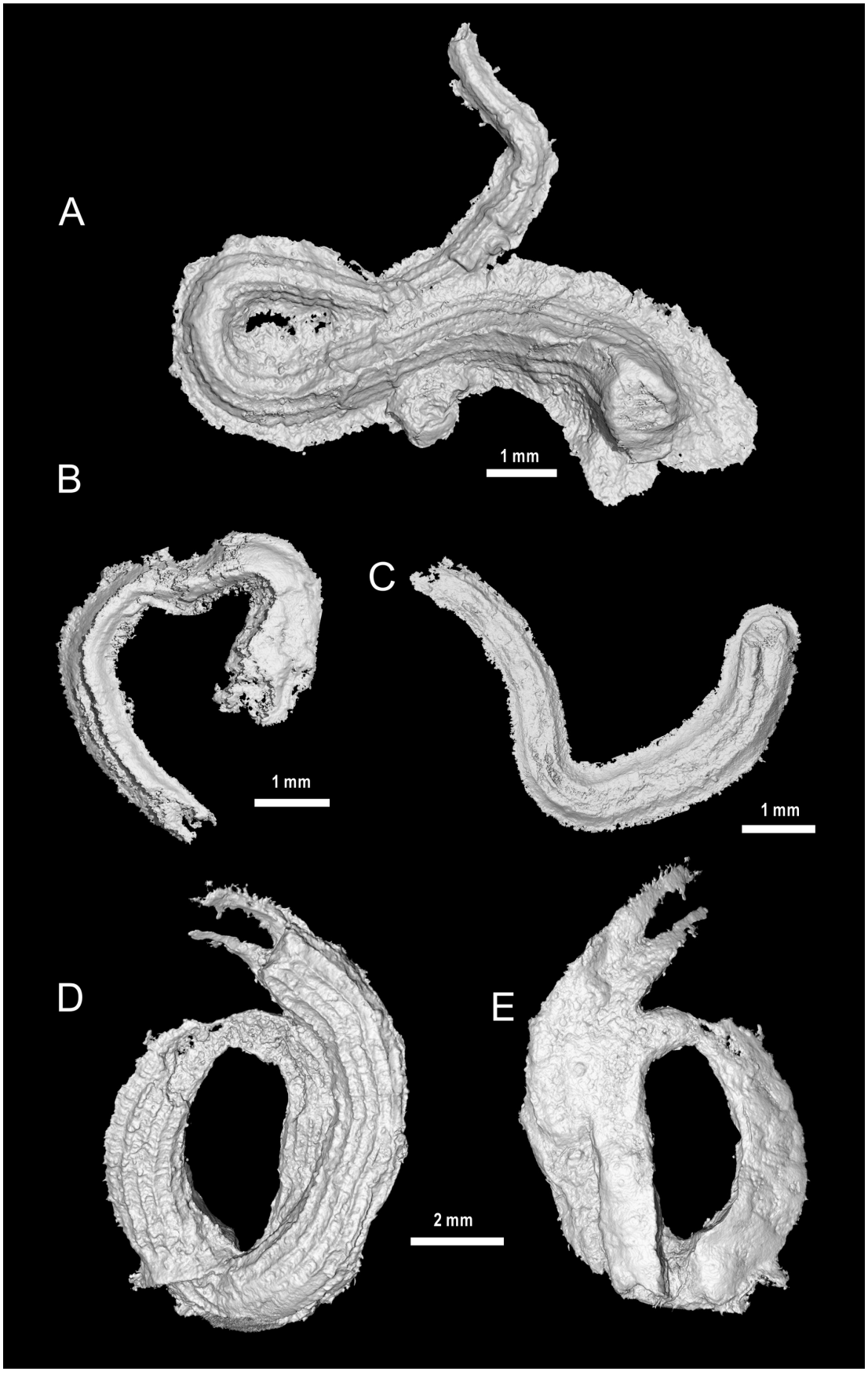

FIGURE 2. Micro-CT scanning of serpulid tubes on Burmese amber. **A**–**C**, Twisted or curved forms. **D**, Coiled form, dorsal view of the tube. **E**, Coiled form, ventral view of the tube.

FIGURE 3. Extant serpulid tubes (**A**, **B**) adhered to Jurassic rocks from the Andaman Sea area, Krabi, Thailand.

longitudinal keels (Figs 1D, 2E), while the ventral surface is slightly flattened and smooth (Fig. 2D). The diameter of this tube is approximately 2 mm, and its length is nearly 2.5 cm.

All these tubes adhered to the amber surface. Morphological comparisons suggest that they originated from tube-dwelling polychaetes, particularly serpulids (Ben-Eliahu & ten Hove, 1992; ten Hove & Kupriyanova, 2009; Bastida-Zavala, 2012). Serpulid polychaetes, which are now classified under Sabellida, are among the most easily recognised annelids due to their filter-feeding radiolar crown, often vividly coloured, and their distinctive calcareous tubes (Rouse & Pleijel, 2001; Rousset *et al*., 2004; Fig. 3). Serpulids are a dominant sessile taxon in confined marine systems (Sanfilippo *et al*., 2017) and are unique among tube-dwelling polychaetes for exclusively inhabiting calcareous tubes (Perkins, 1991; Fischer *et al*., 1989, 2000; Vinn *et al*., 2008).

The oldest known serpulids date back to the middle Permian (Sanfilippo *et al*., 2017, 2018) and were widespread by the Early Jurassic (Ziegler & Michalík, 1980; Flügel *et al*., 1984; Berra & Jadoul, 1996; Cirilli *et al*., 1999; Stiller, 2000; Senowbari-Daryan *et al*., 2007). Despite their abundance and wide distribution, tube-dwelling polychaetes have historically received limited attention in palaeontological research due to

their simple morphology and initially perceived lack of biostratigraphic significance. However, recent studied have increasingly focused on the taxonomy of these tubeworms. Current investigations reveal that the nature and physical properties of the substrate are crucial factors for polychaete colonisation (Ippolitov, 2010). All known serpulids inhabit marine environments across a broad bathymetric range, from intertidal zones to abyssal and hadal depths (ten Hove & Kupriyanova, 2009; Kupriyanova *et al*., 2014). This study not only expands our knowledge of marine biota from the Burmese amber deposit but also offers valuable insights into the palaeoecology and various palaeoenvironments of Mesozoic amber.

Conclusion

This study presents a new instance of a marine assemblage adhered to Burmese amber, providing further evidence that the sedimentary palaeoenvironment of Burmese amber was coastal. The shape of the ambers suggests that they were not transported over long distances before the resin hardened. The tube-dwelling polychaetes likely colonised the amber surfaces after their deposition. The discovery of these polychaete tubes enhances the diversity of marine organisms recorded on the mid-Cretaceous amber from northern Myanmar, and we anticipate finding more marine organisms in future studies.

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