Microbial-tubeworm associations in a 440-million-year-old hydrothermal vent community

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Microorganisms are the chief primary producers within present-day deep-sea hydrothermal vent ecosystems, and play a fundamental role in shaping the ecology of these unique environments. However, very little is known about the microbes that occurred within, and structured ancient vent communities. Their evolutionary history, diversity, and the nature of their interactions with hydrothermal vent animals are largely undetermined. The oldest known hydrothermal vent community that includes metazoans is preserved within the Yaman Kasy massive sulphide deposit of the Ural Mountains, Russia, which dates back to the late Ordovician-early Silurian, approximately 440 million years ago. This deposit contains two types of dwelling-tube fossils attributed to annelid worms – the large tubes of the fossil species Yamankasia rifeia, and the smaller tubes of Eoalvinellodes annulatus. A re-examination of the tube fossils preserved within the Yaman Kasy deposit using scanning electron microscopy reveals the preservation of filamentous microorganisms intimately associated with these tubes. The microfossils bear a strong resemblance to modern hydrothermal vent microbial filaments, including those preserved within the mineralised tubes of the vent polychaete genus Alvinella. The Yaman Kasy fossil filaments represent the oldest animal-microbial associations preserved within an ancient hydrothermal vent environment. They allude to a diverse microbial community, and also demonstrate that fine-scale microbial preservation can also be observed in ancient vent deposits, suggesting the possible existence of similarly-preserved microfossils in even older vent environments.