Ediacaran Macro Body Fossils

Ediacaran (635-542 mya) fossils[i] were considered the very first “Life Explosion” on our planet. Compared to those of the “Cambrian Life Explosion” which took place about several deca-million years later, creatures of the Ediacaran Period[ii] were in general much larger in size than early Cambrian organisms, some were estimated to be more than 1 meter in length, and most are larger than 10 cm in diameter or length, whilst the majority of Cambrian Explosion organisms averaged under 10 cm. The Ediacaran organisms are less understood due to poor preservation, but these fossils play a much more fundamental role in the complex evolution of life forms on earth. Fossil evidence show that the Ediacaran environment differed considerably from that of the early Cambrian. Predators and burrowing organisms, if any, were rare[iii,iv]. Classification of Ediacaran biota has been difficult and, as of now, many hypotheses have been proposed. Seilacher even proposed the Kingdom of Vendobionta[v] as a “failed experiment” in the evolution of complex multicellular organisms, while some others consider them soft-body animals. Besides the relative rarity of Ediacaran fossils, difficulties in understanding and classification may lie in the manner of their preservation. Some micro body fossils of early Ediacaran Period were found[vi], but no well preserved macro body fossils were reported. Currently, it is held that these creatures were buried by volcano ashes or turbidites where the so-called “death mask”[vii] microbial mats played a determining role in cast- or imprint-fossil formation. These include all Ediacaran strata with microbial mat “elephant skin”[viii] identified so far. In casts or imprints, the real body of the original creatures is not preserved. And lack of actual body fossils has precluded study of the very nature of these organisms, hence the difficulties in classification. Here we show the discovery of a significant Ediacaran macro body fossil site that provides not casts or imprints, but actual macro body fossils of the Ediacaran Period that will transform the entire scope of our understanding of life evolution on this planet.

In early 2008, a chunk of fossil collected in 2003 in China’s central YunNan Province, ca. 100 km west of the famous Cambrian Explosion site of ChengJiang, was preliminarily identified as highly probably the very first Ediacaran macro body fossil to

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be discovered[ix]. Fossils collected since then include small body fossil segments of the *Funisia dorothea*[x]. The geology of the site was initially examined, and the stratum identified as pre-Cambrian, i.e., DengYing (Tongying) formation that is on top of the Doushantuo (Toushantou) formation. It is common to find unconformity of red-purple Mesozoic formations, yielding the many famous early dinosaurs, on top of the Pre-Cambrian formations in central YunNan. At this particular site, however, the Mesozoic formations had been weathered, exposing the top of Pre-Cambrian formations.

Preliminary taphonomic observations of this site shows a very different manner of preservation from other Ediacaran fossil sites around the world, where most yielded more directional and complete imprints or casts associated with "elephant skin" death masks. Almost no “elephant skin” was found at this site, however, and dense packed three-dimensional macro body fragments intermixed together non-directionally were very well preserved in very fine grayish limestone (Fig. 1). The find is more like a mixed "salad bowl" containing fossilized chunks of many different Ediacaran organisms.

Initial observations found several morphological types of organism. Most abundant are the tube-shape creatures of various diameters ranging from ca. 5 mm to more than 60 mm with smooth or bumpy exterior surfaces, followed by frond-shaped creatures without holdfast[xi], and other oddities.

Chemical analysis shows the main constituent minerals of these Ediacaran body fossils to be predominantly calcite (calcium□carbonate) intermixed with some siderite (ferrous□carbonate) and rhodochrosite (manganese carbonate). With low phosphorus and very little or none of the rare earth elements inside the fossils, it can be stipulated that there is no evidence of hard tissue bone structural apatite, which in turn suggests soft body organisms.

Microscopic studies, including optical microscope and scanning electron microscope, revealed further important insights on these tubular Ediacaran body fossils. Optical microscopy of a cross cut shows concentric layering rings (Figure 2). Whether this is similar to that of growth rings of trees, and/or connotes other meanings, awaits further investigation.

Scanning Electron Microscopy of a vertical cut of a tubular specimen revealed further intriguing information. Cellular structures are clearly observed (Figure 3). The sizes of

these are within the normal range of cells. In most, a possible “cell nucleus” can be seen as well. There are no thick cell walls, which may be a good indication for ruling out this particular creature as of the Plant Kingdom. However, there is not sufficient evidence as yet to interpret them as part of the Animal Kingdom either. Further investigations on the nature of these cellular structures are needed.

With the discovery of this Ediacaran macro body fossil site, further in-depth studies are now possible to unveil and attempt to answer many important and fundamental questions regarding these mysterious cellular life forms. In comparison to the Ediacaran imprint/cast fossils found and studied up to now, these macro body fossils will enable researchers to cut directly into the inside of their bodies to understand much more of their internal structures instead of merely making guesses from the mannequin. The results of future researches will not only provide more internal structural and morphological understandings in microscopic level of these macro multi-cellular organisms, but may force us to re-evaluate Darwin's evolution hypothesis, and confirm or disprove the hypothesis of the lost Kingdom of Vendobionta.

Huang, Timothy D.[*], Shaw, Jei-Fu[**], Zheng, Liang[†], Huang, ChunLang[‡], Chang, YiLung[§], Yang, ChunWei[ï]

Attachment:

(for reference 9) E-mail letter from Andrew Knoll

Dear Timothy,

Thank you for sending images of the fossils you've discovered in Yunnan. I'm quite convinced that the branching structure is an Ediacaran fossil. The other may be, as well, but I had a hard time evaluating its morphology.

Good luck with your research.

Sincerely,

Andrew Knoll, Harvard University, 8/13/2008

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* Huang, Timothy D., Visiting Professor, National ChungHsing University, DinoDragon International Research Foundation, 43, Lane 525, Sec. 3, AnKang Road, XinDian, Taipei Co., Taiwan, 23156, Rep. of China, E-mail: timd_huang@yahoo.com, Tel: +886-2-2214-0517

** Shaw, Jei-Fu, National ChungHsing University, 250, Kuo Kuang Rd., Taichung 402, Taiwan R.O.C.; E-mail: presid@dragon.nchu.edu.tw

† Zheng, Liang, Department of Paleoanthropology and Vertebrae Paleontology, YunNan Institute of Cultural Relics and Archaeology; E-mail: zhengliang1108@126.com

‡ Huang, ChunLang, KaoXiong Marine University; E-mail: clhuang@mail.nkmu.edu.tw

§ Chang, YiLung, Institute of Cellular and Organismic Biology, Academia Sinica; E-mail: rrn0227@gmail.com

ï Yang, ChunWei, LuFeng County Dinosaur Museum, LuFeng, YunNan, PRC; E-mail: jccg_zhu@yahoo.com.cn

Authors contributions

Huang, Timothy D. is the main investigator and contact; Shaw, Jei-Fu is the coordinator for the research team at ChungHsing University; Zheng, Liang is the principle geologist; Huang, ChunLang did the chemical analyses; Chang, YiLung did optical and scanning electronic microscopy; and Yang, ChunWei is the co-founder of the fossil site.

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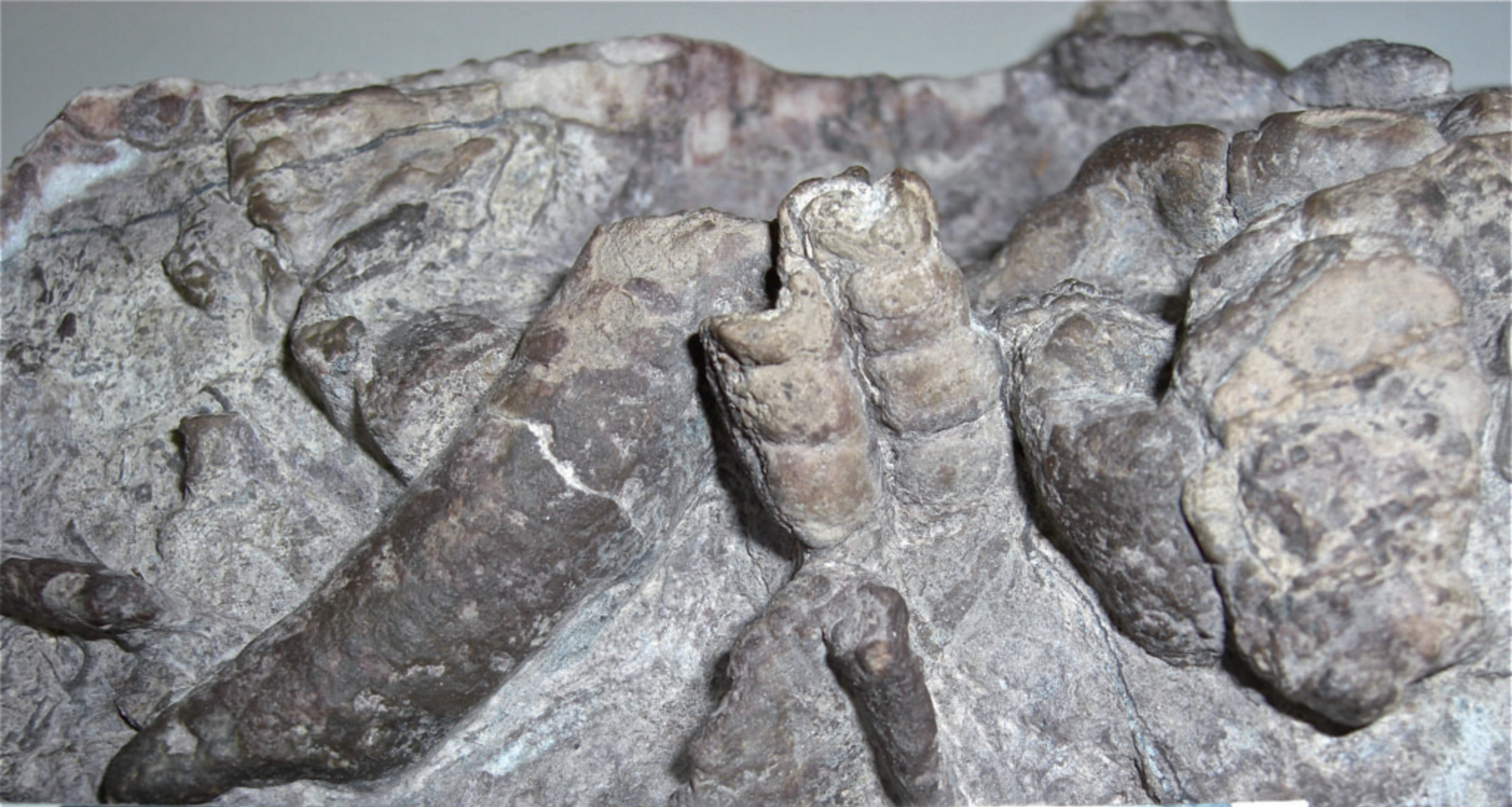
Correspondence and requests for material shall be addressed to

timd_huang@yahoo.com

Figure 1 “Salad Bowl” preservation of Ediacaran body fossils, including a small segment, about 2 cm long of *Funisia dorothea* body fossil with many other to-be-identified Ediacaran body fossils. The scale is 6 cm in length.

Figure 2 Cross section of a tubular Ediacaran body fossil showing concentric tree-ring-like layerings

Figure 3 Scanning Electron Microscope image of vertical section of a tubular Ediacaran body fossil showing possible cell structure




1 cm

HV	Mag	WD	Spot	Sig	Pressure	50.0µm
15.0 kV	2400x	15.0 mm	4.0	SE	0.68 Torr	