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The Mesoproterozoic – no "boring billion"

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Abstract
The authors show that the Mesoproterozoic (1.6-1.0 bn year before present) was no "boring billion" but a "bustling billion" - not only with Stromatolites and their apex in the Calymmian and Ectasian but also with the presence of multicellular organisms. To make it visible a graphical reconstruction was created. For a long time, it was assumed that there existed no noteworthy biosphere on Earth before the Ediacaran (635-542 m year before present) – aside from bacteria which were responsible for the Stromatolites. In literature, they called this age the "boring billion". This term is preserved until today, despite that scientific research came to another result. In the books "Wohin die Spuren führen" (Troppenz 2015) and The New Precambrian" (Troppenz 2017) the actual status of knowledge was compiled, and term "boring billion" replaced by "bustling billion". Term "Montana Biota" (first location of *Horodyskia*) was established for the definitely existing biosphere. For the first time, the authors make an attempt to reconstruct life in the period between 1.88 and 0.78 bn, and revive the "bustling billion".
Keywords: *Precambrian, Mesoproterozoic, multicellular life, boring billion, bustling billion, Montana Biota, reconstruction*

1. Introduction
In contrast to the former view that there are no multicellular organisms in the Pre-Ediacaran and the rejection of such finds as impossible (because of the "wrong" age), researches of the last year's show that there actually was multicellular life in the Paleo- and Mesoproterozoic (Seilacher 2007). The different, interpreted fungoid life-form *Horodyskia* (so-called "string of pearls") was found – after a first find in Montana – also in Australia. In 2010, these Western Australian finds were described by Kathleen Grey and others, working int the "Geological Survey of Western Australia" in "Precambrian Research" (Grey et al. 2017). The new species *Horodyskia williamsii*, they wrote, is a macroscopic fossil of the Mesoproterozoic (Fig 1 and 2).

2. Life in the Mesoproterozoic
The geologist Birger Rasmussen and the palaeozoologist Stefan Bengtson (Rasmussen et al. 2002) gave account of macrofossils of the Sterling Biota in southwestern Australia from a stratum between 1215 and 2016 million years of age. In "Science" (2002) they write: "The structures resembling trace fossils clearly have a biological origin and suggest the presence of vermiform, mucus-producing, motile organisms." They call them "hairpins" because of their form.
In 2007, Bengtson and Rasmussen (Bengtson et al. 2007) took the next crucial step together with Bryan Krapez (University of Western Australia): They gave the hairpin fossils an internationally valid trace fossil name: *Myxomitodes stirlingensis*. At the same time, they refined their former statements. They claimed the fossils were 1.8 to 2 billion years old and came from sediment formed under the influence of storms, longshore currents, and tidal currents. They continued: "Sandstones contain a megascopic fossil biota represented by discoidal fossils similar to the Ediacaran *Aspidella* as well as ridge pairs... The ridges run parallel or nearly parallel for most of their length, meeting in a closed loop at one end" (Fig 3). Interesting is the absence of Charnia-like fossils, so the interpretation of *Aspidella/Discomedusa* or other round fossils as "holdfast" seems to be put into question. Concerning the interpretation of *Aspidella* as medusa, there exist new research results. In 2013 Latha R. Menon et al. described *Aspidella terranovica* (Billings 1872) from the ca. 560 Ma Fermeuse Formation of Newfoundland/Canada, and "sedimentary fabrics indicating progressive vertical movement" (Menon et al. 2013).
Birger Rasmussen (Australia), Subir Sarkar (India) and four other co-workers ascertained in "Geology" in 2002 (Rasmussen et al. 2002) that using state-of-the-art methods, they were able to determine for certain the age of the Chorhat sandstone (lower Vindhyan) to the time period "between 1628 (+/- 8) million and 1599 (+/- 8) million years". The bedding-plane markings were interpreted as burrows of burrow worms.
Stefan Bengtson, palaeozoologist, Martin Whitehouse, geologist, Veneta Belivanova, specialist for microfossils, all at the "Swedish Museum of Natural History" in Stockholm as well as Birger Rasmussen, a sedimentologist from Australia, published their research results in 2009 in the journal "Proceedings of the National Academy of Sciences" (PNAS/USA).

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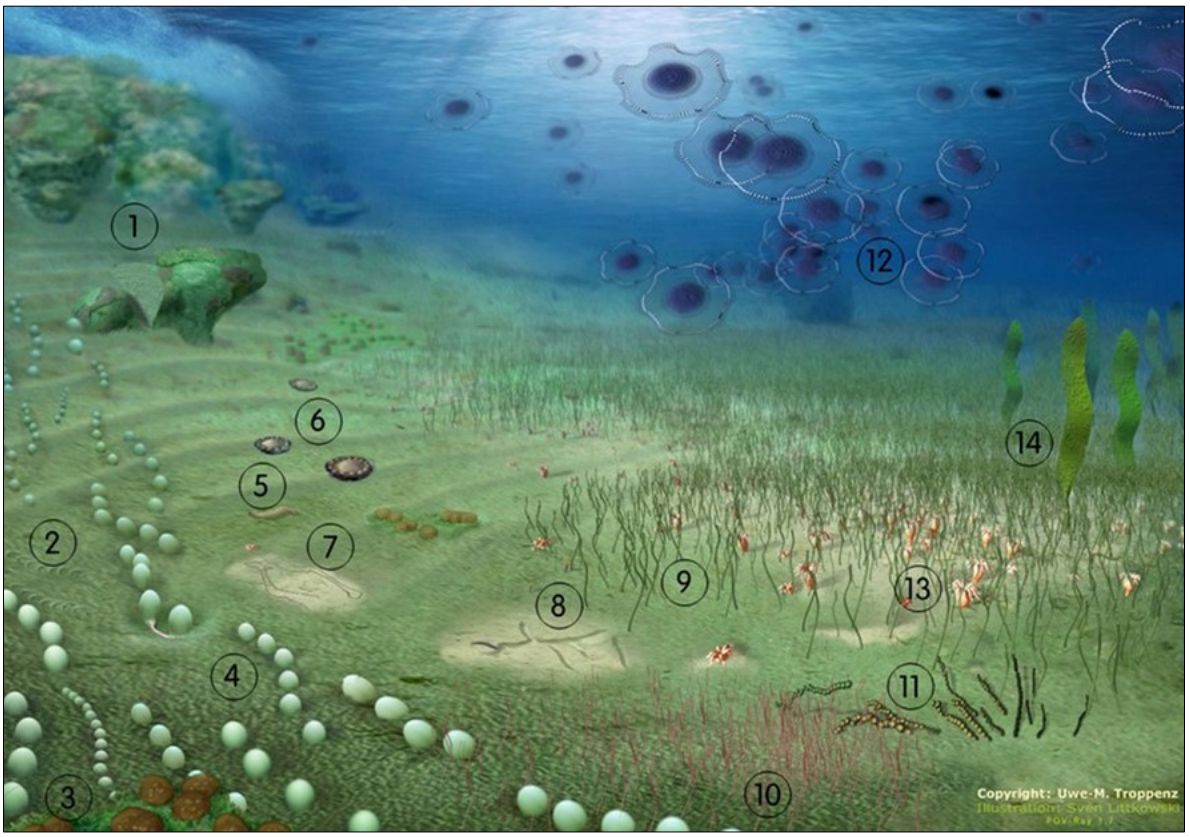

Fig 1. Reconstruction of the Montana Biota (Proterozoic, Statherian-Tonian, 1.88-0.78 bn): (1) Stromatolites (maximum 1.25 bn); (2) ?trace, Västervik structure long (1.88-1.85 bn, D); (3) ?brown alga, Västervik structure round (see 2); (4) *Horodyskia* sp. (1.4 - 0.42 bn); (5) "Wellenwurm" (1.35 - 1.2 bn, D); (6) „Gotländer Mysterium" (1.4-1.3 bn, D); (7) trace *Myxomitodes stirlingensis* (2.0-1.8 bn); (8) Chorhat traces (1.62-1.59 bn); 9) Alga *Grypania spiralis* (1.87-0.60 bn); (10) red alga *Ramathallus lobatus* (1.6 bn); (11) Protozoan *Orbisiana* sp. (see 7); (12) *Aspidella/Cyclomedusa* and other round structures (see 7); (13) ?sea anemone *Olivooides multisulcatus* (see 7); (14) ?Alga (1.56 bn).

Fig 2. Fossil of *Horodyskia williamsii*, the string of beads, as it is called, Mesoproterozoic, approx. 1.4 billion years, Backdoor Formation, Western Australia. - Photo: Redpath Museum, McGill University, Montreal/Canada (Creative Commons)

Fig 3. *Aspidella*-like organisms were found in pre-Ediacaran layers. This is an Ediacaran fossil from Norway for comparison only. Collection: Troppenz

The microfossils were accompanied by a range of macroorganisms representing "distinct forms in the Lower Vindhyan" as far as their appearance is concerned. In this context, the following fossils from the Ediacaran and the Cambrian are mentioned: *Vindhyanitubulus semriensis* (tubular specimen), *Olivooides multisulcatus* (coralloid), *Orbisiana* (chain-like fossil), *Konglingiphyton* (alga) and *Flabellophyton strigata* (alga). This means that there must have been

similar fossils more than 1.5 billion years ago (Bengtson et al. 2009) (Fig 4).

Bengtson and his colleagues said it clearly: "The Vindhyan have a long history of megafossil discoveries that sometimes have had difficulties getting into the mainstream literature because of uncertainties about the age, sometimes also because the reports themselves have not been convincingly documented." But: "All these forms are highly significant for our understanding of biotic diversity in the Lower Vindhyan" and the early evolution of multicellular eukaryotes.

Particularly important for the evidence – that the Mesoproterozoic life forms were multicellular - were the discoveries in China (Zhu et al. 2016) of 1.56-billion-year-old probable algae (up to 30 cm) with preserved cells, and the 1.6–billion-year-old microscopic red algae with preserved cells in India (Bengtson et al. 2017) (Fig 5).

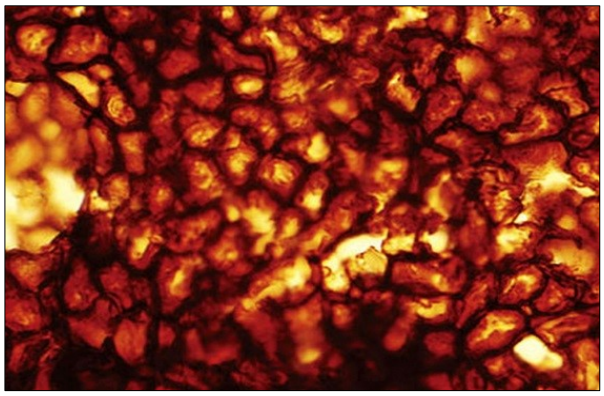

Fig 4. Alga-like fossils from Yunshan/China with a length of up to 30 cm. The special feature: The cells are preserved (picture). Their age is 1.56 billion years. In accordance with ZHU et al. 2016.

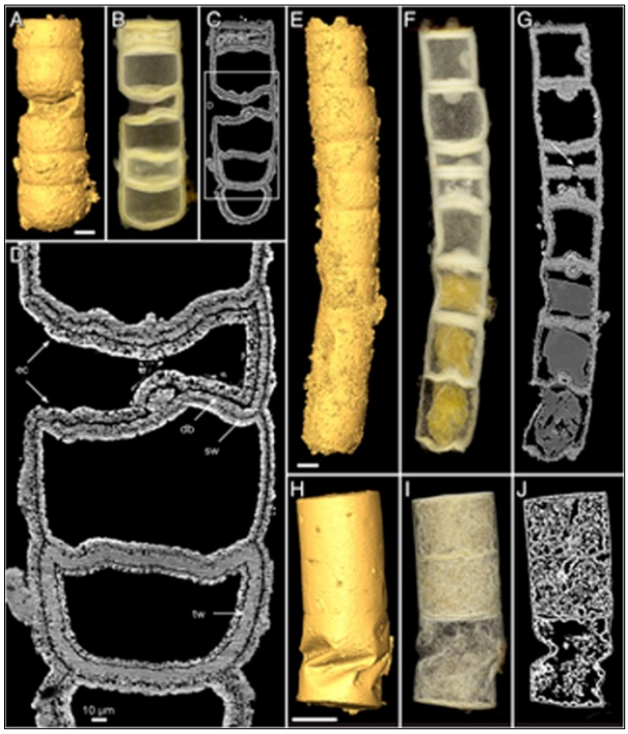

Fig 5. *Rafatazmia chitrakootensis* is the name Stefan Bengtson gave to these multicellular microscopic red algae from India. Their age is reported to be 1.6 billion years (Bengtson 2017).

3. Explanations of the graphical reconstruction

There are several, previous reconstructions of life in the Ediacaran (back 635 million years). Two years ago, a picture showing the organisms of the Franceville Biota (2.1 billions) was issued by Marcel Laverdet in: "Aux Origines de la Vie" (El Albani et al. 2016). For the meantime such a reconstruction is missing. The Montana Biota we present here not only refers to the Mesoproterozoic (1.6-1.0 billions) but starts in the Paleoproterozoic with 1.88 billion old - Västervik structures (Troppenz et al. 2016), Grypania (Han and Runnegar 1992) and others - and ends in the Neoproterozoic with the beginning of total ice ages ("Snowball" or "Iceball Earth") dated 0,78 billion years ago, approximately from the Statherian and up to the Tonian (Fig 6 and 7). We include in this reconstruction (Fig 1) most of the known multicellular organisms dated from this period, which doesn't means that they simultaneously existed.

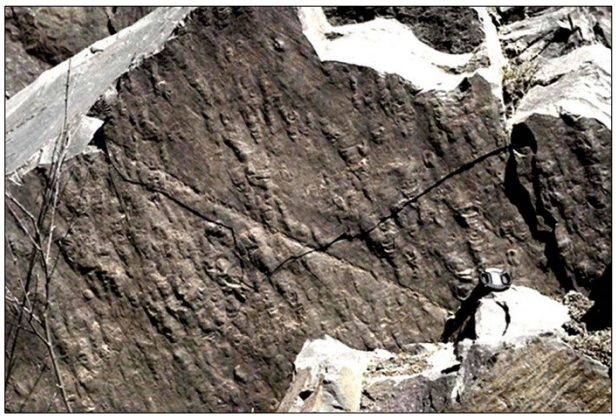

Fig 6. Oblong structures in the Västervik rock, where wave-formed ripples can be found. These structures may be interpreted as movement tracks caused by worms, according to Troppenz et al. 2016.

Fig 7. Round structures in the 1.88 billion year-old rock of Västervik/Sweden. As there are no petrographic explanations for these structures, surveyor Roland Vinx, of Hamburg (Germany) presumes a biogenic origin. Gregory Retallack, from the University of Oregon, account for them as possible relics of round brown algae (such as the recent *Colpomenia peregrina*), in accordance to Troppenz et al. 2016.

Science advances, and with the developing technology, there surely will be more classifications and reconstructions based on new palaeontological research. We included not only significant fossils, but also some dubious fossils, too (marked with D). We also want to indicate a dilemma: on the one hand there should be the effect of a lower water world – on the other hand the reader should realise the life-forms. Therefore we had problems with the colouring, and likewise with the proportions of the organisms. Organisms in the range of millimetre or micro-range had to be illustrated larger than they are – to be visible. But the other organisms (except of the stromatolites and a kind of alga) are in the range of cm, so the necessary distortion is tolerable, and these are only three fossils in the graphic.

4. Methodology

The render software POV-Ray was used for many elements of the prehistoric scene. POV-Ray is not just a regular render engine like all the others, its scene description language is a programming language, and therefore POV-Ray can be used to calculate and show a wide range of scientific features. In fact, many scientists are using POV-Ray to compute and illustrate physical or other processes. POV-Ray, with its unique features to prevent over-heating of laptops in space (it gets a feature called "Duty Cycles" and addresses the different physical laws of hot-air expansion or behaviour in zero-G environments), was used on the ISS - the International Space Station - and performed quite well. Beside the scientific use by the research community, POV-Ray opens a wide range of possibilities for the commercial and private user too. POV-Ray, now in version 3.7, is available without any costs involved: povray.org, a group of individuals, develops and improves this render engine since decades, some peple being part of the team since decades. New features are being discussed in its newsgroups, of which the co-author is an active member.

5. Conclusions

Through the development of the graphical reconstruction (Fig 1), we became aware of the tinny line linking scientific accuracy and necessary phantasy, in attempting to reconstruct the look of a billion year-old biota. While filling the picture with more and more Mesoproterozoic organisms, we realized that this pre-Cambrian world was bustling - and “boring” in no case. If we want to know more about life in the oldest times, we have to pay more attention on ages and should not discount it as “boring”. So, the discussion about the so-called "Wellenwurm" (Troppenz 2014) from Germany, has certainly contributed to the fact that the oldest sedimentary rock in the northern European beds should increasingly being taken into account by collectors and scientists (Fig 8).

Fig 8. The so-called “Wellenwurm” (“worm on waves”) is a glacial erratic boulder found in northern Germany, originating from Sweden. It is a piece of Dala sandstone (1.2-1.3 bn), with ripple marks and a worm-like structure (left). Troppenz collection.

References

Bengtson S, Belivanova V, Rasmussen B, Whitehouse M (2009) The controversial 'Cambrian' fossils of the Vindhyan are real but more than a billion years older, *Proceedings of the National Academy of Sciences* 106 (19): 7729-7734.

Bengtson S, Rasmussen B, Krapez B (2007) The Paleoproterozoic megascopic Sterling biota, *Paleobiology* 33 (3): 351-381.

Bengtson S, Sallstedt T, Belivanova V, Whitehouse M (2017) Three-dimensional preservation of cellular and subcellular structures suggests 1.6 billion-year-old crown-group red algae, *PLOSbiology* 15(3):1-38.

El Albani A, Macchiarelli R, Meunier A (2016) Aux origines de la vie: Une nouvelle histoire de l'évolution, *Dunod*, Paris 224 pp.

Grey K, Yochelson EL, Fedonkin MA, Martin DM (2010) Horodyskia williamsii new species, a Mesoproterozoic macrofossil from Western Australia, *Precambrian Research* 180(1-2): 1-17.

Han TM and Runnegar B (1992) Megascopic eukaryotic algae from the 2.1-billion-year-old negaunee iron-formation, Michigan, *Science* 257(5067): 232-235.

Menon LR, Mcilroy D, Brasier MD (2013) Evidence for Cnidaria-like behaviour in ca. 560 Ma Ediacaran Aspidella, *Geology* 41 (8): 895-898.

Rasmussen B, Bengtson S, Fletcher IR, Mcnaughton NJ (2002) Discoidal Impressions and Trace-Like Fossils More Than 1200 Million Years Old, *Science* 296 (5570): 1112-1115.

Rasmussen B, Bose PK, Sarkar S, Banerjee S, Fletcher IR, Mcnaughton NJ (2002) 1.6 Ga UPb zircon age for the Chorhat Sandstone, lower Vindhyan, India: Possible implications for early evolution of animals, *Geology* 30 (2): 103-106.

Seilacher A (2007) Trace Fossil Analysis, Springer, 226p.

Troppenz UM (2014) Wohin die Spuren führen (Vol. 1), *Parchim* 172 pp.

Troppenz UM (2015) Wohin die Spuren führen (Vol. 2) *Parchim* 192 pp.

Troppenz UM (2017) The new Precambrian, No "boring", but bustling billions in a succession of evolutions and global catastrophes, *Tetrada Verlag Parchim*, 140 pp.

Troppenz UM, Vinx R, Schmälzle D (2016) Bemerkenswerte Sedimentstrukturen in der 1,88-1,85 Milliarden Jahre alten Västervik-Formation, *Schweden "-Mitteilungen der Naturforschenden Gesellschaft Mecklenburg (NGM)* 16(1): 3-9.

Zhu S, Zhu M, Knoll AH, Yin Z, Zhao F, Sun S, Qu Y, Shi M, Liu H (2016) Decimetre-scale multicellular eukaryotes from the 1.56-billion-year-old Gaoyuzhuang Formation in North China" *Nature communications* 7: 11500.