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 Calymmician 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 “busting 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 Paleao- and Mesoproterozoic (Selacher 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 veriform, 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).
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 Pre-Ediacaran layers. This is an Ediacaran fossil from Norway for comparison only. Collection: Troppenz

Ediacaran and the Cambrian are mentioned: Vindhyanitabulus 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 Laverde 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 Statheria 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.
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 people 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 tiny 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


