Extreme reefs: Analyses of modern bryostromatolite ("bryolith") reefs from marginal environments in the Netherlands with comparisons to ancient analogues

George William Harrison, Lene Claußen, Christian Schulbert, and Axel Munnecke
Geozentrum Nordbayern, Friedrich-Alexander Universität Erlangen-Nürnberg, Erlangen, Germany
(g.william.m.harrison@gmail.com)

Marginal environments sometimes serve as natural time machines, replicating conditions of ancient environments and thus inducing similar adaptations and symbioses. Few environments are more marginal than the brackish, arsenic and titanium rich, and periodically euxinic ponds found in the Zeeland (Netherlands). These ponds contain layered, stationary bioherms of alternating bryozoans and microbialites (bryostromatolites); similar structures are known from the Late Miocene of the Paratethys and the isotopic excursions in the Silurian as well as recent hypersaline lagoons in Australia. Critical study of the modern bryostromatolites will help paleontologists understand the conditions under which bryostromatolites formed in the past.

This study applied modern methods to analyze the microstructures and minerology of bryostromatolites from the Netherlands. These bryostromatolites contained alternations of *Einhornia crustulenta* bryozoans and gypsum-cemented microbes. Bryostromatolites formed in distinct stages, alternating between a phase of bryozoan layers and a phase where microbes and cements grew in tandem over the dead bryozoans; this microbial phase likely coincides with temporary anoxia/euxinia. The microbes, tentatively identified as cyanobacteria, showed a thrombolitic texture cemented with gypsum. This gypsum was deposited while the microbes were alive, suggesting they were alive during the euxinic phases and participating in sulfide-based photosynthesis. The bryoliths were otherwise poor in fauna, containing only a few species of mollusks, arthropods, polychaetes, and diatoms. All of these factors highlight the extreme environment under which modern and possibly ancient bryoliths formed.