Ibarra, Y., Corsetti, F. A., Greene, S. E., & Bottjer, D. J. (2015). Microfacies of the Cotham Marble: a tubestone carbonate microbialite from the Upper Triassic southwestern UK: a reply. *PALAIOS*, 30, 806-809. <https://doi.org/10.2110/palo.2015.068>

Peer reviewed version

Link to published version (if available):
[10.2110/palo.2015.068](https://doi.org/10.2110/palo.2015.068)

[Link to publication record in Explore Bristol Research](#)
PDF-document

University of Bristol - Explore Bristol Research

General rights

This document is made available in accordance with publisher policies. Please cite only the published version using the reference above. Full terms of use are available:
<http://www.bristol.ac.uk/red/research-policy/pure/user-guides/ebr-terms/>

- 1
- 2
- 3
- 4
- 5
- 6
- 7
- 8
- 9
- 10
- 11
- 12
- 13
- 14
- 15
- 16
- 17
- 18
- 19
- 20
- 21
- 22
- 23
- 24
- 25
- 26
- 27
- 28
- 29
- 30
- 31

1

certainly not restricted to that region (Fig. 1A) as Mayall and Wright incorrectly assert in their comment.

With respect to the continuity of the Cotham Marble, we do not imply the Cotham Marble, in any ‘form’, is a single continuous layer. The Cotham Marble microbialites are patchy and occur as individual mounds (Owen, 1754), which is stated in the Abstract section of Ibarra et al. (2014). Although the ‘continuity’ of phases that we demonstrate in Figure 2 of Ibarra et al. (2014) focuses on samples collected in and around Bristol (up to ~20 km apart), similar phases have been reported in outcrops as far south as the Devon coast (Hamilton, 1961; Gallois, 2007; Fig. 1A). In fact, samples collected well outside of Bristol that occur approximately 100 km apart show considerable fine scale lateral persistence despite occurring as discontinuous mounds (Fig. 1B-C). The succession of facies (e.g., a shallowing upward cycle of subtidal wackstones/packstones overlain by intertidal mudstones) can repeat in sedimentary successions, such that a similar succession of facies in isolation from far-removed localities would not be taken for isochronous deposition. However, the identical microstratigraphy, down to the mm-scale succession of microfacies, found ~100 km apart (Fig. 1B-C) suggests some phases of the Cotham Marble were deposited at the same time under identical regional-scale forcing. The significance of the lateral persistence of the dendrolitic and stromatolitic phases is at least twofold: 1) widespread, non-local environmental factors were the dominant controls on microbialite formation, despite evidence for local microbial influence and 2) although their morphology is not entirely uniform across the region, the striking persistence of fine-scale textures across tens of kilometers suggests some phases of the Cotham Marble were deposited under isochronous conditions. Thus, when combined with examples from Bristol and Lower Woods, Figure 1 validates the aerial extent presented in Ibarra et al. (2014).

Stratigraphic and Depositional Setting

Mayall and Wright state that the term ‘dead zone’ (cf. Mander et al., 2008) is used to support the case that the Cotham Marble is an ‘indicator’ of extinction. While we agree that the depositional setting is debated and the depauperate zones surrounding the Cotham Marble may be attributable to a fluctuating environment and potential salinity changes, we do not base our association of the Cotham Marble with the extinction event solely on its stratigraphic co-occurrence with an interpreted ‘dead zone’. We emphasize the Cotham Marble’s 1) lateral extent, 2) co-occurrence with an interpreted prasinophyte bloom also found in other European Upper Triassic sections, and 3) occurrence at the same level as a stable isotopic excursion of $\delta^{13}\text{C}_{\text{org}}$, a global marker of the end-Triassic extinction

(Hesselbo et al., 2002, 2004). It is the combined manifestation of all of the listed aspects that is used to interpret the Cotham Marble microbialites as previously overlooked, yet relevant, geobiological sedimentary archives intimately associated with the events of the end-Triassic. Therefore, the geochemical and biological changes observed across the Tethys realm during the Late Triassic are captured in the Cotham Marble despite any putative environmental restriction that may or may not have existed.

The issues surrounding the abrupt faunal and facies changes recorded in the Upper Cotham Member (including depositional setting) have been discussed elsewhere (Radley et al., 2008). In light of that and other discussions, it is clear the depositional setting of the Cotham and Langport Members continues to be disputed (Hallam et al., 2004; Radley et al., 2008). We demonstrate the Cotham Marble itself, upon initiation of the first dendrolitic phase, contains conflicting evidence of depositional conditions by the presence of echinoderm fragments (stenohaline conditions) and calcite pseudomorphs after gypsum (desiccation) (Figure 3E-D in Ibarra et al., 2014) and thus state on page 2 that the depositional setting is interpreted as a shallow coastal environment that alternated between periods of restriction and connection to open marine waters.

Presence of *Tasmanites*

Mayall and Wright ask for clarification as to the lateral extent of the organic-walled putative ‘disaster taxon’ *Tasmanites*. All of the samples we investigated contained organic-walled microfossils we interpret as *Tasmanites*; the northernmost site we investigated is Lower Woods and the southernmost site is Charton Bay (Fig. 2), a range of ~100 km.

THE ROLE OF *MICROTUBUS* IN FORMING THE COTHAM MARBLE

Mayall and Wright demonstrate notable examples of *Microtubus* in their Figures 2-3. However, the samples that were the subject of investigation in Ibarra et al. (2014) have a mesostructure distinct from those shown in Figure 2 of Mayall and Wright. Perhaps the reason for the ‘reduced form’ of the Cotham Marble figured by Mayall and Wright is because *Microtubus* may have inhibited the development of the ‘typical’ dendrolitic structures of the Cotham Marble rather than promoting them, as originally proposed by Wright and Mayall (1981). On page 8 of Ibarra et al. (2014), it is stated that ‘we found *Microtubus* to be a significant component of the microbialites only in our sample from Pinhay Bay’ but it is not implied that *Microtubus* is completely absent in the northern sections. Figures 10B-C in Ibarra et al. (2014) contain tubular structures typical of *Microtubus* (and see also Figure 3, with examples of *Microtubus* from Bristol samples).

What we wished to clarify in Ibarra et al. (2014) is that *Microtubus* is not *necessary* for the formation of the dendrolitic phases. For example, Figure 3 illustrates only a marginal presence of *Microtubus* in a typically figured example of the ‘arborescent’ structures. Notice that most of the spar-filled ovoid structures are the result of evenly spaced microbial mat branching, which can manifest as round structures when viewed in only two dimensions. While *Microtubus* is present in the samples collected near Bristol (Fig. 3) and across the region, the tubular microfossil is not intimately associated with the dendrolitic structures, ruling out ‘a *Microtubus*-algal association’ giving rise to the dendrolitic phases. The structures in Figure 14C-D of Ibarra et al. (2014) are irregularly shaped, vary in size, and do not have the same micritic wall of *Microtubus* shown in Figure 14A.

The reason why this observation and distinction is significant is because the Cotham Marble is an exceptionally preserved example of the ways in which microbial mats can grow into intricate patterns, leaving behind evenly spaced cavities (now filled with calcite cement) that can resemble burrows and other tubular fossils. The similarity in size and shape of the various spar-filled ovoid structures of the Cotham Marble dendrolites is deceptive (Fig. 14 in Ibarra et al., 2014), and in most instances will require the use of multiple slabs along several orientations together with petrographic study to decipher taxonomic differences.

ADDITIONAL COMMENTS

Mayall and Wright feel that a minor injustice has been done when discussing their interpretation of the ‘hedge’ features. We simply highlight that the clumping of microbes is not the only mechanism that forms structures resembling the ‘hedges’ of the Cotham Marble. Recently, Mata et al. (2012) showed that the production of gas bubbles within mats can cause microbial filaments to become oriented, providing a potential alternative mechanism for the formation of the ‘hedges’.

Mayall and Wright suggest that the application of the term tubestone to the Cotham Marble is incorrect. Citing the definition of tubestones as “laterally continuous stromatolite sheets that enclose and isolate intra-stromatolite depressions filled with sediments” (Corsetti and Grotzinger, 2005, p. 361), they argue the Cotham Marble is not a ‘continuous sheet’ and therefore not a tubestone. In fact, the key feature of a tubestone (Corsetti and Grotzinger, 2005) is, in plan view, the isolated intra-stromatolite depressions filled with sediment (that is, the “tubes”—hence, the term “tubestone”). Thus, as demonstrated in Figure 4A-B in Ibarra et al. (2014), the Cotham Marble microbialites display a classic tubestone morphology in plan view where the microbialite encloses depressions filled with sediment. Aside from megascopic differences, several diagnostic meso- to microscopic characteristics

125 of tubestone microbialites are consistent with the Cotham Marble's morphology: intradendrolite
126 depressions filled with sediment, a reticulate microbialite network in horizontal cross section, bridging
127 laminae, and shrub textures (Ibarra et al., 2014).

128 SUMMARY

129 It seems that Mayall and Wright have overlooked outcrops located south of Bristol and along
130 the Devon coast that contain the 'classic' form of the Cotham Marble (Fig. 1). Although the Cotham
131 Marble is patchy and the unit is morphologically variable, laminated and dendrolitic phases can be
132 traced for at least 100 km (Fig. 1), thus making the microbialite unit, in our opinion, remarkably
133 laterally extensive, encompassing a conservative aerial extent of ~2,000 km².

134 Ibarra et al. (2014) highlight the Cotham Marble's previously unreported lateral extent and the
135 widespread co-occurrence of *Tasmanites*. These observations along with the stratigraphic level at
136 which the Cotham Marble occurs, link the Cotham Marble to the end-Triassic extinction in the
137 southwestern United Kingdom and to other end-Triassic sections across Europe.

138 The Cotham Marble continues to be known primarily for its 'Landscape-like', dendrolitic
139 features. The paucity of *Microtubus* in the typical dendrolitic 'Landscape' shown in Figure 3 and as
140 explained in Ibarra et al. (2014), reveals that although *Microtubus* is indeed associated with the
141 Cotham Marble, it is not integral to the construction of its iconic dendrolitic phases. The samples
142 shown by Mayall and Wright appear to be an unusual exception and would likely fall under one of the
143 alternate 'forms' (cf. Short, 1903) as they exhibit a reduced dendrolitic morphology, highlighting that
144 unusual occurrences can unintentionally bias broader conclusions. These examples are nonetheless
145 informative in illustrating the vast extent of the enigmatic *Microtubus* in the Upper Cotham Member
146 across the region.

147 REFERENCES

- 148 CORSETTI, F.A., and GROTZINGER, J.P., 2005, Origin and Significance of Tube Structures in
149 Neoproterozoic Post-glacial Cap Carbonates: Example from Noonday Dolomite, Death Valley,
150 United States: *Palaos*, v. 20, p. 348-362.
- 151 GALLOIS, R.W., 2007, The stratigraphy of the Penarth Group (Late Triassic) of the east Devon coast:
152 *Geoscience in South-West England*, v. 11, p. 287-297.

153 HALLAM, T., WIGNALL, P., HESSELBO, S.P., ROBINSON, S.A., and SURLYK, F., 2004, Discussion on
154 sea-level change and facies development across potential Triassic–Jurassic boundary horizons,
155 SW Britain: *Journal of the Geological Society*, London, v. 161, p. 1053-1056.

156 HAMILTON, D., 1961, Algal growths in the Rhaetic Cotham Marble of Southern England:
157 *Palaeontology*, v. 4, p. 324-333.

158 HESSELBO, S.P., ROBINSON, S.A., and SURLYK, F., 2004, Sea-level change and facies development
159 across potential Triassic–Jurassic boundary horizons, SW Britain: *Journal of the Geological*
160 *Society*, London, v. 161, p. 365-379.

161 HESSELBO, S.P., ROBINSON, S.A., SURLYK, F., and PIASECKI, S., 2002, Terrestrial and marine
162 extinction at the Triassic-Jurassic boundary synchronized with major carbon-cycle
163 perturbation: A link to initiation of massive volcanism?: *Geology*, v. 30, p. 251-254.

164 IBARRA, Y.I., CORSETTI, F.A., GREENE, S.E., and BOTTJER, D.J., 2014, Microfacies of the Cotham
165 Marble: A tubestone carbonate microbialite from the Upper Triassic Southwestern, U.K.:
166 *Palaaios*, v. 29, p. 1-15.

167 MANDER, L., TWICHETT, R.J., and BENTON, M.J., 2008, Palaeoecology of the Late Triassic extinction
168 event in the SW UK: *Journal of the Geological Society*, London, v. 165, p. 319-332.

169 MATA, S.A., HARWOOD, C.L., CORSETTI, F.A., STORK, N.J., EILERS, K., BERELSON, W.M., and SPEAR,
170 J.R., 2012, Influence of gas production and filament orientation on stromatolite microfabric:
171 *Palaaios*, v. 27, p. 206-219.

172 OWEN, E., 1754, *Observations on the Earths, Rocks, Stones and Minerals, for some miles about*
173 *Bristol*.

174 RADLEY, J.D., TWITCHETT, R.J., MANDER, L., and COPE, J.C.W., 2008, Discussion on palaeoecology of
175 the Late Triassic extinction event in the SW UK: *Journal of the Geological Society*, London, v.
176 165, p. 988-992.

177 SHORT, A.R., 1903, On the Cotham Marble: *Proceedings of the Bristol Naturalists' Society*, v. X, p.
178 135-149.

179 WRIGHT, V.P., and MAYALL, M.J., 1981, Organism-Sediment Interactions in Stromatolites: an
180 Example from the Upper Triassic of South West Britain, *in* Monty, C., ed., Phanerozoic
181 Stromatolites: Springer-Verlag, Berlin Heidelberg New York.

182 FIGURE CAPTIONS

183 Fig. 1. —Cotham Marble samples from well outside the Bristol area. **A)** Double ‘Landscape’ sample
184 from Culverhole Point, Devon, (~85 km south of Bristol) showing the common phases of the
185 Cotham Marble (L=Laminated, D=Dendritic); British Geological Survey sample MR_5769 (the
186 sample is approximately 10 cm across). **B)** Cotham Marble high-resolution scan from Charton
187 Bay (~85 km south of Bristol). **C)** Cotham Marble high-resolution scan from Lower Woods
188 (~20 km north of Bristol).

189 Fig. 2. —Putative *Tasmanites* microfossils from Charton Bay, Devon. **A)** *Microtubus* and organic-
190 walled microfossils. **B—D)** Arrows denote a thick cell wall and linear sutures typical of
191 *Tasmanites*; scale bar = 20 µm.

192 Fig. 3. —Dendrolitic phases of the Cotham Marble. **A)** High-resolution scan of the typical
193 ‘arborescent’ phase of the Cotham Marble; Bristol Museum and Art Gallery, number Cb 4127.
194 **B)** Photomicrograph of dendrolitic structure highlighting the various spar-filled ovoid
195 structures. Samples A and B are from Bristol.

A

fill

*Microtubus*100 μm **B****C****D**

A

Evenly-spaced microbial mat branching

Putative former
gas bubbles

Microtubus

1.0 mm

B

branching

bubble?

Microtubus

branching

1.0 mm