

Biogeosciences Discuss., author comment AC1  
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## Reply on RC1

Jutta E. Wollenburg et al.

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Author comment on "Permanent ectoplasmic structures in deep-sea *Cibicides* and *Cibicidoides* taxa – long-term observations at in situ pressure" by Jutta E. Wollenburg et al., Biogeosciences Discuss., <https://doi.org/10.5194/bg-2021-62-AC1>, 2021

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Response to

Comment of Susan T. Goldstein (Referee) (comment in blue, response in black)

We are very grateful for the very positive and helpful comments of Sue Goldstein that helped to improve the manuscript. We addressed all comments in the revised version.

The authors report observations on living specimens of several species of *Cibicides*-/*oides*, species that are important epibenthic taxa widely used in paleoceanographic studies. Individuals were maintained at ambient or near ambient pressures in a highly specialized culturing system with circulating seawater. The authors report highly resistant structures formed by the individual foraminifera, and the ability of individuals to move along some of these structures. Although observations are limited by the thickness of the walls of the culture system, they are nonetheless novel and demonstrate the extent to which these foraminifera modify their surroundings by constructing a useful "scaffolding" to aid in motility and feeding.

How many of the individuals observed made these structures?

**We added the respective information to the respective positions in the results chapter. To 3.2, we added 'In 68 out of 100 specimens ectoplasmic 'roots' were observed. In an unknown proportion of the rest (32 specimens), such structures might have existed but due to the large working distance and/or a less optimal observational position of the specimens in the aquarium not noticed.' To 3.2.2., we added 'Distinct ectoplasmic 'trees' were observed in 6 of the 50 studied *C. pachyderma* specimens, others might have been overlooked as the experimental set-up just allows a vertical view insight the aquarium.' To 3.2.3, we added 'Ectoplasmic 'twigs' are directed above the umbilical side into the water column, thus, in our experiments they could only be observed in specimens that had**

**attached themselves on an, in respect to the observation, ideal position on the aquarium's wall. In 16 of the 50 observed *C. pachyderma* specimens ectoplasmic 'twigs' were observed. '**

It would be good to know what these structures are composed of and whether these materials might be unique to these particular species. Perhaps this will be addressed in future research.

**Yes, it is impossible to perform fixations for transmission electron microscope analyses in our high-pressure aquaria. Such investigations have to be performed in different settings at atmospheric pressure.**

I have just a few comments:

- Who was the first to describe the granular appearance of reticulopodia in foraminifera? The authors cite Goldstein (1999), but this has been known for quite a long time. I (vaguely) recall reading this description in Rhumbler (1909). Given the content of the paper, I suggest that the authors track down the origin of this

**According to our research the first notification was Schultze (1854). We added this reference and Hedley (1964) as additional literature examples. We also added Dujardin's (1835) work which led to the term Rhizopoda.**

- Who was the first to refer to the foraminiferal shell as a test that is internal? Cushman (1948) talks about the test as an internal structure, and judging from the associated illustration, the observation may date as far back as Schultze (1854). Again, if this point is to be reviewed in the Discussion, the authors should track down these earlier

**From what we could figure out from the old papers, Schultze (1854) illustrated an 'ectoplasmic sheet' around *E. macellum*, but did not any further comment on that. On the other hand Cushman (1929, older version of the 1948er edition) stated that in many taxa the foraminiferal shell would an internal one but did not elaborate on details and affected species. We added this information, and that in more recent years it is regarded as a structure limited to a certain area of the test and to the time of new chamber formation. The respected text part at the beginning of the discussion now reads 'This study describes the shell of *Cibicidoides* spp., as an internal 'skeleton' rather than an external feature. Already in Schultze's work from 1854 an ectoplasmic sheet can be suspected to cover the illustrated *Elphidium macellum* (as *Polystomella strigilatum*) test (Schultze, 1854)plate IV, fig. 1). Cushman (Cushman, 1928) even stated that in**

many taxa the foramiferal shell would an internal one but did not elaborate more on which species he had in mind. In studies on foramiferal calcification processes, in planktonic foraminifera, *Ammonia* sp., and *Amphistegina lessoni* a protective cytoplasmic envelope is described as a structure restricted to times and areas when/where new shell material is precipitated (Bé et al., 1979; de Nooijer et al., 2014; Erez, 2003; Tyszka et al., 2019).

- When the pumps are 'shut down', does the pressure also drop, or does this just affect the currents?

**A shut-off valve is installed after the overflow valve to ensure that pressure doesn't drop once pumps are shut-off. We added a respective footnote to the legend of Fig. 8 ('A shut-off valve following downstream the overflow valve prohibited a pressure drop in the high-pressure aquaria when the pumps were shut.')**

- A couple of typos: line 83, convocal: confocal; line 121: inversed:

**We corrected the typos accordingly.**

- The authors used calcein, but I didn't see any mention of the occurrence of calcification. Did any calcification occur?

**No, as stated in Wollenburg et al. (2018b) growth of *Cibicidoides mundulus* required the presence of artificial sediments. The observations in this study were done on aquaria without artificial sediments.**

- "Et al." has been omitted from a number of the in-text citations, and these should be corrected.

**We corrected the author lists in endnote so that now 'et al.' is displayed.**