Biogeosciences Discussions

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Comment on bg-2021-141

Ralf Schiebel (Referee)

Referee comment on "Population dynamics and reproduction strategies of planktonic foraminifera in the open ocean" by Julie Meilland et al., Biogeosciences Discuss., https://doi.org/10.5194/bg-2021-141-RC1, 2021

The manuscript of Julie Meilland and coauthors on “Population dynamics and reproduction strategies of planktonic Foraminifera in the open ocean” adds valuable perspectives to the discussion on the reproduction strategy of planktic foraminifers. Assemblage data from plankton tows sample in-situ populations are suited for analyses of the respective population dynamics. Using the same statistical approaches, which have been applied in earlier studies facilitates comparability, and confirm earlier results and interpretations. Despite the 14-day long data set that “only” covers half of a synodic lunar cycle, i.e., half of the full reproduction cycle assumed to be executed by most modern planktic foraminifers, the paper presents valuable assumptions on the reproduction systematics of four species.

Overall, the paper is well written concerning the reproduction strategies of modern planktic foraminifers. In contrast, the section 4.4. on “Consequences for proxies and biogeochemical cycles”, which discusses the paleoceanographic implications of the finding presented here, is rather poorly executed, and may be rewritten, or removed from the manuscript. I would suggest publication of the paper following some larger and smaller improvements given in the following.

1. More general comments

Plankton are present in the ocean at all times. As ecological conditions change, small (juvenile, dormant, or resting) stages of some species may profit and start growing to be eventually sampled by plankton nets of a certain mesh size. The required ecological conditions do not possibly occur at predefined water depths intervals, but may vary across

the regional and global ocean. This is possibly also the case in the study presented here. Whereas it is implied in the paper (although not explicitly stated) that the region sampled and analyzed here may be characterized by rather homogenous hydrologic conditions, this may not be true for the ecological conditions affecting the population dynamics and (assumed) systematic reproduction of planktic foraminifers. As can be seen for the Figure 2 (panel A) of the manuscript, the region is heavily affected by eddies (Fig. 1). Both cold and warm core eddies are characterized by upwelling and downwelling at their centers and margins, which affects trophic state and vertical transport of waters bodies and the plankton included within. Vertical transport of planktic foraminifers both up and down the surface water column may consequently act here in the same way as it does in other regional of the ocean, and would affect the population dynamics and interpreted reproduction scenarios discussed here.

Figure 1. Sea surface anomaly and temperature in the Cape Verde Basin on August 5, 2021, showing cold and warm core eddies, some of which are indicated by fat lines and dots at their center. Similar eddies are visible from SST in the panel a of Figure 2 of the Meilland et al. manuscript.

Ontogenetic terms such as juvenile and adult are not used in the correct way in many places of the manuscript, and may need to be changed to “small” or “large” (e.g., lines 109, 226, 281). Just assuming that individuals of a certain size of a certain species would be “adult” in the sense of being capable of reproduction, as in the Figure 6, is speculation. Proof of reproduction may only come from the presence (or absence) of gametogenetic (GAM) calcite on top of the shell (e.g., G. bulloides, Schiebel et al., 1997). Unfortunately, GAM calcification does not occur in some species such as G. ruber, and size of earliest possible reproduction may be identified from population dynamics. There is no proof for the assumption that reproductive maturity is reached as late as in the very large size classes as shown in Figure 6. If this would be the case, reproduction would be possible only in the few specimens that grow very large. Alternatively, the change from "mortality" to "reproduction" may occur at the size class from 140-180 microns and 200-300 microns in G. ruber and G. menardii, at which size the adult stage is reached. In O. universa, "trochospiral and spherical" may be the correct term (line 209). Please see also lines 411-412, and 415, where speculation about the unproven connotation of test size fraction and ontogenetic stage is repeated.

2. More specific comments

Line 168: “concentrations” may be changed to “standing stocks” in case of live assemblages

Line 311: the statistical significance should be proven by numbers, and not assumed

Line 387: "reproductive mortality" this is a strange term for the process you want to describe here. Please google "reproductive mortality", which has a completely different connotation. I would suggest to simply use "reproduction" instead.

Lines 395-396: This may be written in passive, since it may not be the foraminifer's decision: "This is because the life of a foraminifer ends at gamete release."

Lines 425-426: Better start sentence with: "Small individuals..." The size class >100 microns does possibly not include juvenile stage of most of your species, but rather neanic and adult stage only. Plase have a look at Schiebel and Hemleben (2017, and references therein); most importantly the papers of Geert-Jan Brummer.

Lines 428-429: „The constant presence of juveniles and dead specimens of foraminifera from

all species suggest that reproduction may have occurred continuously during our survey." This is a misconception. This only shows that plankton grows and dies at all times.

Line 440, and other places: The concept of synchronized reproduction was possibly introduced by Ahuve Almogi-Labin (1984); see also Erez et al. 1991; the first ideas on this may have emerged as early as in 1967 from Berger and Soutar...

Line 445: We have learned from Spero et al. (2015) that the spherical chamber of O. universa may include up to seven day and night layers of calcite, which means that gametogenesis may not really be imminent upon first formation of the spherical chamber.

Lines 477-478: „This contrasts with the OVM pattern suggested for G. menardii by Schiebel and Hemleben (2017),…" These patterns vary with ecological conditions. I have found more individuals of G. menardii at greater depth, which would also largely exclude photosymbiont activity.

Lines 482-482: According to Takagi et al. (2019), photosymbiosis in G. menardii is merely facultative.

Line 496: This is possibly the latest (and only secondary) reference of many earlier (and original) references.

Lines 529-535: Why should gametes develop this strange behaviour and escape from the place where they are released? Gametes are possibly released at certain depths to provide them with optimum conditions for survival, and straight ascent would decrease the survival rates. This makes no sense.

Line 549: Survival of a population would be ensured if only one offspring of one parent would make it to reproduction, which would be much less than 5 % in case of 100,000 offspring.

Lines 571-572: „… but often interpreted literally, assuming that all specimens follow the depicted ontogenetic trajectory." This is possibly your very personal interpretation of the literature.

Line 619: Why ALL 3 clades? How many clades are there according to your information? I would count on 4, which includes the Hastigerinidae.

Figure 7: I read the depth trajectories in the opposite direction. Reproduction may occur around day 1 or 2 near the thermocline / DCM. From day 6 or 7 (3 at the earliest in G. glutinata), more small individuals occur in the overlying water column; these small individuals, however, did already grow to the size of >100 microns. In the following, increasingly more larger individuals of G. ruber and G. glutinata occur in the surface water column. This is quite similar to the development of G. bulloides in the NE Atlantic (Schiebel et al. 1997). Larger G. menardii did not occur in the surface water column; this is quite similar to what I have seen in G. menardii (Schiebel and Hemleben 2017).

Please also note the supplement to this comment:
https://bg.copernicus.org/preprints/bg-2021-141/bg-2021-141-RC1-supplement.pdf