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RECOMMENDATION

Insights into mechanisms of coccolithophore speciation: How useful is cell size in delineating species?

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Based on reviews by:
Andrej Spiridonov and one anonymous reviewer

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A recommendation of

Razmjooei MJ and Thibault N (2022). Morphometric changes in two Late Cretaceous calcareous nannofossil lineages support diversification fueled by long-term climate change. *PaleorXiv* nfyc9, ver. 4, peer-reviewed by PCI Paleo. DOI: 10.31233/osf.io/nfyc9

Calcareous plankton gives us perhaps the most complete record of microevolutionary changes in the fossil record (e.g. Tong et al., 2018; Weinkauf et al., 2019), but this opportunity is not exploited enough, as it requires meticulous work in documenting assemblage-level variation through time. Especially in organisms such as coccolithophores, understanding the meaning of secular trends in morphology warrants an understanding of the functional biology and ecology of these organisms. Razmjooei and Thibault (2022) achieve this in their painstaking analysis of two coccolithophore lineages, *Cribrosphaerella ehrenbergii* and *Microrhabdulus*, in the Late Cretaceous of Iran. They propose two episodes of morphological change. The first one, starting around 76 Ma in the late Campanian, is marked by a sudden shift towards larger sizes of *C. ehrenbergii* and the appearance of a new species *M. zagrosensis* from *M. undulatus*. The second episode around 69 Ma (Maastrichtian) is inferred from a gradual size increase and morphological changes leading to probably anagenetic speciation of *M. sinuosus* n.sp.

The study remarkably analyzed the entire distributions of coccolith length and rod width, rather than focusing on summary statistics (De Baets et al., In Press). This is important, because the range of variation determines the taxon's evolvability with respect to the considered trait (Love et al., 2022). As the authors discuss, cell size in photosymbiotic unicellular organisms is not subject to the same constraints that will be familiar to researchers working e.g. on mammals (Niklas, 1994; Payne et al., 2009; Smith et al., 2016). Furthermore, temporal changes in size alone cannot be interpreted as evolutionary without knowledge of phenotypic plasticity and environmental clines present in the basin (Aloisi, 2015). The more important is that this study cross-tests size changes with other morphological parameters to examine whether their covariation supports inferred speciation events. The article addresses as well the effects of varying sedimentation rates (Hohmann, 2021) by, somewhat implicitly, correcting for the stratophenetic trend using an age-depth model and accounting for a hiatus. Such multifaceted approach as applied in this work is fundamental to unlock the dynamics of speciation offered by the microfossil record.

The study highlights also the link between shifts in size and diversity. Klug et al. (2015) have previously demonstrated that these two variables are related, as higher diversity is more likely to lead to extreme values of morphological traits, but this study suggests that the relationship is more intertwined: environmentally-driven rise in morphological variability (and thus in size) can lead to diversification. It is a fantastic illustration of the complexity of morphological evolution that, if it can be evaluated in terms of mechanisms, provides an insight into the dynamics of speciation.

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Appendix

Reviews by Andrej Spiridonov and one anonymous reviewer, DOI: 10.24072/pci.paleo.100011.