

# Biometric analysis of the genus *Toweius* across the Early Eocene Climatic Optimum (EECO, ~53–49 Ma) at ODP Site 1258, Demerara Rise

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<https://doi.org/10.58998/jnr3204>

The genus *Toweius* represents a prominent group of coccolithophores during the late Paleocene and early Eocene that is known for its evolutionary linkage and abundance turnover to *Reticulofenestra* during the Early Eocene Climatic Optimum (EECO). Typically, *Toweius* coccoliths exhibit elliptical to circular shapes with a central area comprising conjunct nets or bars and a distinctive architecture that features three concentric tubes (inner, middle, and outer) along with proximal and distal shields. However, the discovery of a small morphotype (termed herein *Toweius* sp. II) from the tropics, which lacks the typical inner and middle R-units, raises important questions about the origin and evolutionary significance of this taxon.

This study investigated the biometric and morphological variation in *Toweius* across the EECO at Ocean Drilling Program (ODP) Site 1258, focusing on defining the small morphotype and exploring its relationship with other *Toweius* species. Observations using light microscopy (LM) and scanning electron microscopy (SEM) revealed that the absence of a central tube, along with a circular shape and wide central opening, was present in nearly all specimens of *Toweius* sp. II. A biometric analysis indicated that *Toweius* sp. II exhibits a unimodal size distribution with a range of 2.25–3.4  $\mu\text{m}$  and an average of 2.65  $\mu\text{m}$ , distinctly smaller than the medium-sized *Toweius* (3.2–5.4  $\mu\text{m}$ ) that dominated early EECO assemblages. Similarly, other metrics, such as coccolith aspect ratio, central diameter to total length ratio, and circularity index, further distinguish *Toweius* sp. II from other members of the genus.

While the observed biometric disparity could be attributed to a preservation bias, *Toweius* sp. II likely derived from a *Toweius* species of similar size. The consistent presence of this taxon throughout early and peak EECO times suggests that dissolution may not have been significant. As such, this taxon probably represents either a state of malformation in calcification or an actual ecophenotypical variant of *Toweius* with a restricted occurrence in the tropics. In conclusion, the distinct biometric features and lower coccolith mass of *Toweius* sp. II point to decreased calcification and possibly an ecological adaptation that may have facilitated its persistence much longer within the EECO than other *Toweius* species.