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Precession control on intraspecific size variation of the planktic foraminifer Orbulina universa (Early Messinian, Late Miocene, Crete): temperature and/or salinity effects

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Microfossil and stable isotope data from deep-water sediments of Late Miocene age in the Mediterranean region have revealed a stepwise restriction of the Mediterranean prior to the Messinian crisis modulated by cyclical changes in palaeoevironments responding to orbital precession. The understanding of these changes, however, remains semi-quantitative, because thresholds governing foraminiferal distributions only explain the presence or absence of taxa, and their use in palaeoenvironment reconstructions is complicated be side effects induced by additional variables.

This work is based on a geological section in Crete (Greece) exposing sediments of Early Messinian age. We use abundance data of planktic and benthic foraminifers in combination with size measurements of the planktonic foraminifer Orbulina universa (n = 6777). The foraminifer fauna is dominated by planktic taxa and displays a pronounced cylclicity of warm, oligotrophic (i.e. O. universa) and cold, eutrophic taxa. This cyclicity corresponds with the lithological changes from laminated into homogeneous marl related to the precessional cycle. In beds rich in O. universa, the size of the tests exactly falls into the range known from the (global) tropical Miocene ocean. In beds rich in cool, eutrophic foraminifers, the test of O. universa are reduced in size by up to 50 %. Factors controlling size variation in modern O. universa are complex, however, water temperature in combination with primary productivity explains most of the variation. Using the modern relationship, average annual water temperature change over the precessional cycle was $\sim$8°C. Because primary productivity was high when O. universa grew to small size only, size variation might have been controlled by temperature alone. Nonetheless, the temperature variation found is larger than that inferred from other methods and implies additional influences caused by other factors, i.e. salinity, on growth.