Regularity in the quaternary variations of Noelarhabdaceae morphology

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It is now well established that environmental conditions drive changes in the coccolith morphology of *Emiliania huxleyi* and other Noelarhabdaceae taxa. Evolution also has played a very important role in shaping the morphology of coccolithophores. Here, we investigate the manner in which the interwoven influences of environment and evolution control coccolith shape variation on orbital timescales. The western Pacific warm pool was chosen because it is far from oceanic boundaries and because sea surface temperatures are relatively stable (2–3°C variation) at different time scales (from seasonal to 100kyr). We studied morphological changes in Noelarhabdaceae from three well dated cores that were retrieved around Papua New Guinea (PNG): MD97-2140 and MD05-2520, which were retrieved to the north of PNG and, cover the last 1.7Ma and 0.4Ma respectively, and MD05-2530, which was retrieved to the south of PNG and covers the last 0.8Ma. In every sample from those cores, the biometry of at least 300 Noelarhabdaceae coccoliths was estimated at a time resolution of less than 2kyr. Coccolith images were taken in cross-polarized light and were identified with a deep-learning software (SYRACO). Measurements of mass, length, and width were then produced automatically. A bimodal distribution in size was apparent in most of the samples with a mode separation of around 3μm. The mass and the size of the large and small groups show mirrored (opposite) fluctuations. The rhythms of these fluctuations closely follow precession and eccentricity cycles of the Earth's orbits around the sun. We therefore infer that seasonality played an important role in shaping coccoliths. The reason why large and small coccoliths have opposite long-term mass trends remains enigmatic. Two obvious possibilities are differential depth habitats and/or growth seasons. The relative importance of evolution and the environment on coccolith morphological patterns will be discussed in detail.