STABLE ISOTOPES AND THE ENIGMA OF PLANKTONIC FORAMINIFER EVOLUTION

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Oxygen ($\delta^{18}O$) and carbon ($\delta^{13}C$) isotopes of planktonic foraminifer test calcite both give information of the preferred depth of calcification of living and extinct species. In their evolutionary history, the planktonic foraminifera have repeatedly evolved homeomorphic test shapes. Isotopes indicate that the ecology of Paleocene and Eocene faunas was similar to that of modern planktonic foraminifera: A variety of photosymbiotic species lived stratified in the surface mixed layer while non-symbiotic species exploited the thermocline and sub-thermocline depths below. However, unlike in the Recent, angular and keeled species mostly lived in the mixed layer whereas globular spinose forms dominated the thermocline. Thus, there is surprisingly little correlation between test shape and habitat.

The stable isotopic trends of a variety of evolving lineages have now been analyzed. These allow us to test whether phyletic transitions and branching speciations tend to be correlated with habitat changes (such as successive invasions of deeper water) or partitioning between sister species. Published studies of *Globoconella* and *Fohsella* are discussed, along with new data for *Paragloborotalia pseudokugleri - P. kugleri* (ODP Site 926), *Globigerinoides - Praeorbulina - Orbulina* (ODP Site 871), *Pulleniatina primalis - P. spectabilis* (ODP Site 873), *Globorotalia plesiotumida - G. tumida* (ODP Site 873), and *Fohsella* (ODP Site 871). Again surprisingly, there is little evidence that fundamental changes in morphology have corresponded to significant changes of habitat: most evolutionary innovation has occurred in the absence of any isotopic signal. Conversely, some examples of habitat shift occurred without significant changes in test architecture.

The enigma of planktonic foraminifer evolution that arises from these isotopic studies is that we do not know what is driving it.