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The paleogeographic evolution of the orthophragminids of the Paleogene

Marcelle BouDagher-Fadel and G David Price
UCL, Office of the Vice-Provost (Research), London, United Kingdom (m.fadel@ucl.ac.uk)

Orthophragminids are larger benthic foraminifera (LBF), and together with the nummulitids were the major rock-forming foraminifera from the middle Paleocene to the late Eocene. Today, porous, LBF-bearing, Paleogene limestones, which occur globally from the Pacific and Atlantic margins of the Americas to the Indo-Pacific, form potentially valuable oil reservoirs, and their biota have formed the basis of the definition of three paleobiogeographic provinces, namely those of the Americas, Tethys, and the Indo-Pacific. The orthophragminids of the western part of the Tethyan Province have been studied extensively, however, the other provinces are less well characterised, and until now the origin and paleogeographic development of this group have not been fully articulated. New material described here allows the clear definition of a fourth, South African paleobiogeographic province, and when combined with refined biostratigraphic dating based on new material from the Americas, Europe, South Asia and SE Asia, enables their paleogeographic and biostratigraphic evolution to be determined. Critically, the occurrence of cosmopolitan planktonic foraminifera within LBF assemblages enables the first occurrences of various LBF forms within each province to be dated relative to a well-calibrated planktonic zone (PZ) age. From this, we infer that the orthophragminids originated in the Americas during the Paleocene, probably between the late Danian (PZ P1c, 63.5 Ma) and the early Selandian (PZ P3a, 61.6 Ma). By the middle Paleocene the orthophragminids had migrated across the Atlantic to the previously isolated West African coast at the extreme of Tethys, probably during global sea-level low stands at 60.3 Ma and again at 56.4 Ma. After this the American Province again became isolated. In Tethys, the orthophragminids migration followed two paths: northeastward through the Tethyan corridor in the late Paleocene (Thanetian), and south in the earliest Eocene (Ypresian) to South Africa. The Tethyan forms evolved during the Eocene into many lineages, which in turn migrated, after a few million years of their first appearance, into the Indo-Pacific, where they again became isolated and diversified further. Meanwhile the South African forms remained similar to their American ancestors in both small size and external ornamentation, but their internal evolution closely followed that of Tethys forms. The origination of LBF stock in the Americas and their subsequent migration to Tethys and South Africa, is not unique to the orthophragminids. The appearance of American stock in Tethys after low sea-level stands has also been inferred to have occurred with the nummulitids, and in more recent geological epochs with the lepidocyclinids and the miogypsinids. The development of high resolution PZ dating, tied to accurate times scales, now opens up the possibility of correlating evolution events with paleoclimate and tectonic processes, and so is beginning to provide unprecedented insights into the phylogenetic and paleogeographic evolution of LBF and potentially other marine forms.