processes in solitary and colonial radiolarians have begun to elucidate some of the adaptive mechanisms that may account for the remarkable success of these holoplankters in diverse oceanic environments. The diversity of algal symbionts including dinoflagellates, prasinophytes, and a brown-pigmented alga has been documented by light and electron microscopy, and the role of the symbionts in host nutrition has been determined for some solitary and colonial species using cytochemical and radioisotopic techniques. Fine structure analysis of predatory behavior and food vacuole contents shows that some larger solitary spumellarian species are omnivores consuming crustacean prey and other microzooplankton in addition to algae. This is in contrast to prior assumptions that most solitary radiolarians are microherbivores and therefore changes our conception of their niche in oceanic environments.

Fine structure examination of skeletal morphogenesis in a number of solitary and colonial species has clarified the mechanism of skeletal deposition and pattern of skeletal ontogeny. These studies contribute to our understanding of cellular specialization in radiolarians, their physiological adaptive mechanisms to a holoplanktonic existence, and the biological factors correlated with patterns of skeletal morphogenesis that may be useful in interpreting radiolarian evolution and paleoecology.

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Trace Fossils of Middle Mississippian Carbonates, South-Central Indiana

Middle Mississippian (Meramecian) predominantly carbonate units of south-central Indiana, which include the Harrodsburg, Salem, St. Louis, and Ste. Genevieve Limestones, included the following environments: (1) sabkha (supratidal flats); (2) lagoons; (3) oolitic- and calcareous-sand bars and shoals; and (4) deeper shelf impure carbonates. Probably as functions of salinity and rate of deposition, these rocks range from being intensely bioturbated to a lack of recognizable bioturbation. Although several of the trace fossils cannot be currently assigned to recognized ichnogenera, the following forms have been recorded: *Chondrites*, *Cylindrichnus*(?), *Planolites*, *Teichichnus*, and a *Rhizocorallium*-type trace.

Degree of weathering exerts a considerable control on field recognition of the various forms. Intense weathering obliterates the slight tonal differences that aid in identification of traces in the fine-grained carbonates. However, in some calcarenites, certain taxa are only recognizable in weathered material and are nearly impossible to discern in polished slabs.

Factors related to episodic influx of fine-grained terrigenous detritus exert a considerable control on preservation of the various forms. Field exposures of carbonates that contain shale partings commonly exhibit abundant traces that are only apparent in polished slabs of more massive carbonates. The similarity of trace-fossil assemblages from these shallow-water carbonates with traces of deeper shelf Cretaceous chalks of the U.S. Western Interior further supports the contention of a high degree of preservational control.

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Eocene-Oligocene Boundary Problems, West Coast, North America

Correlation of the international Eocene-Oligocene boundary with the provincial biostratigraphic framework of the northeast Pacific margin has been and continues to be controversial. The controversy centers about historical nomenclature and correlations, and current correlations based on planktonic fossil group.

The Geological Society of America's C. E. Weaver Committee published the first interdisciplinary correlation chart for the Cenozoic rocks of the western United States in 1944. The committee placed the Eocene-Oligocene boundary at the base of the "Keasey" Molluscan Stage and Refugian Benthic Foraminiferal Stage. These correlations were based on faunal similarity between Pacific Coast and European assemblages.

The most useful provincial boundaries of Late Eocene to Oligocene age are the Narizian-Refugian and Refugian-Zemorrian Benthic Foraminiferal Stage boundaries. Reevaluation of the Refugian Stage has recently been completed. The stage boundaries have been correlated to the international geologic time scale using planktonic microfossils.

Rigorous stratigraphic superposition of planktonic floras and faunas from continuously deposited foraminiferal-rich rocks results in correlation of the Narizian-Refugian Benthic Foraminiferal Stage boundary with the calcareous nannofossil zonal boundary NP18/NP19, and with planktonic foraminiferal Zone P15, in California, Oregon, and Washington. Thus, the Narizian-Refugian boundary represents a provincial chronostratigraphic datum of early late Eocene age.

Planktonic assemblages are rare in samples from above and below the Refugian-Zemorrian Benthic Foraminiferal Stage boundary. In California this boundary is commonly at an unconformity or without superposition of diagnostic faunas. In southwestern Washington the Refugian-Zemorrian boundary occurs in continuously deposited and foraminiferally rich sections. Nannofloras assigned to Zone NP22 and planktonic foraminifera assigned to the interval of Zones P17 to P20 occur in strata containing foraminifera assigned to the Zemorrian Benthic Foraminiferal Stage. Nannofloras assigned to the intervals of Zones NP20 and NP21, and Zones NP19 to NP21, and planktonic foraminifera assigned to the intervals of Zones P16 and P17, and Zones P15 to P17 occur in strata containing foraminifera assigned to the Refugian Benthic Foraminiferal Stage. Therefore, the Refugian-Zemorrian boundary occurs within planktonic Zones NP21 and P17, roughly correlative with the international Eocene-Oligocene boundary.

The above correlations result in the reassignment of much of the 1944 Weaver chart's Oligocene to the Eocene: the "Keasey" and "Lincoln" Molluscan Stages and the Refugian Benthic Foraminiferal Stage are now recognized as late Eocene in age.

Radiometric calibration of the provincial boundaries is not yet possible. Whole rock potassium-argon and fission track dates are available but both have very large error bars or lack adequate biostratigraphic control to be useful.

Fossiliferous stratigraphic sections have rocks with sufficient remanent magnetism for magnetostratigraphic studies but to date only reconnaissance data are available.

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Tectonic Control of Eocene Arkosic Sediment Deposition, Oregon and Washington

Chronostratigraphic and geographic studies of Eocene arkosic sandstones suggest deposition during a "volcanically quiet" interval resulting from the westward jump of the Farallon-Kula plate subduction zone in Oregon and Washington.

The Eocene arkosic sandstones were deposited as part of a broad fluvial plain–coastal plain–shelf margin basin complex extending throughout Oregon and Washington between uplands