EVOLUTIONARY PATTERNS AT THE TERRESTRIAL EOCENE-OLIGOCENE BOUNDARY IN NORTH AMERICA

PROTHERO, Donald R., Dept. Geology, Occidental College, Los Angeles, CA 90041

Recent breakthroughs in magnetostratigraphy and $^{40}Ar/^{39}Ar$ dating have shown that the boundary between the Chadronian and Orellan land mammal "ages" (long thought to be mid-Oligocene) correlates with the Eocene-Oligocene boundary (about 33.9 Ma). This boundary gives an exceptionally dense, detailed record of faunal, floral, and climatic changes, well constrained by magnetostratigraphy and radiometric dating.

Evidence from paleosols and land floras (Retallack, 1992) document a striking cooling and drying event across this boundary, with a woodland vegetation (greater than 1000 mm annual precipitation) replaced by a wooded grassland (500 mm annual precipitation). According to Wolfe (1992), mean annual temperature declined almost 13°C, and the annual range of temperature increased dramatically from 5°C to about 25°C. Sedimentological evidence from eastern Wyoming (Evanoff et al., 1992) show an abrupt transition from moist floodplains to semi-arid landscapes with abundant wind-blown volcaniclastic dust. Most of these events took place over a few thousand years. This is certainly one of the most severe climatic events in the Cenozoic.

Late Eocene land snails (Evanoff et al., 1992) are large-shelled subtropical taxa now typical of central Mexico, indicating a mean annual range of temperature of 16.5°C and annual precipitation of about 450 mm. In the early Oligocene, these were replaced by drought-tolerant small-shelled taxa indicative of a warm-temperate open woodland with a pronounced dry season. Reptiles and amphibians (Hutchison, 1992) show a trend toward cooling and drying, with aquatic forms (crocodilians, freshwater turtles, and salamanders) replaced by land tortoises; size reduction in turtles also indicates increased aridity. Mammals show only minor changes across this boundary. A few archaic groups which may have depended on woodland browsing (such as the rhino-like brontotheres, the camel-like oromerycids, and several archaic rodent groups) are the only taxa to go extinct. Minor speciation events occur in horses, the deer-like leptomerycids, and camels. The oreodont *Miniochoerus* shows a gradual dwarfing of about 30% over about 100,000 years. Most other species show no significant changes across this climatic crisis, although some change in relative abundance. Most mammals show stasis spanning millions of years before and after this transition, and some of the land snails are virtually indistinguishable from modern taxa.

Traditional Neo-Darwinian theory would predict that animals should evolve rapidly in response to such strong climatic selection. Instead, most animals respond by going extinct and being replaced by unrelated forms, or do not change at all. A few show punctuated speciation events at the boundary, and only one shows prolonged gradual dwarfing. This suggests that animals are not infinitely flexible "balls" on an adaptive landscape, but have some kind of internal homeostasis that prevents gradual change in response to selection. Extinction, emigration, or punctuated speciation events seem to be the preferred response.

All citations from Prothero, D.R., and W.A. Berggren (eds.), 1992, *Eocene-Oligocene Climatic and Biotic Evolution*, Princeton Univ. Press, Princeton, N.J., 568 pp.