FAUNAL RESPONSE TO CLIMATIC EVENTS: TESTING THE TURNOVER PULSE HYPOTHESIS

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

Vrba (1985) suggested that episodes of turnover in the Plio-Pleistocene mammalian faunas of southern and eastern Africa were correlated with major climatic changes, and this has been corroborated by recent climatic data (de Menocal, 1995). How well does this generalization apply to the rest of the fossil record? In at least three well-documented climatic events in Cenozoic mammals, the opposite seems to be true: major climatic changes led to little or no change in mammalian faunas.

The end of the middle Eocene (37 Ma, magnetic Chron C17n1) was a major mass extinction in the marine realm, particularly in warm-adapted plankton and benthos. In North America, this corresponds to the Duchesnean-Chadronian boundary, when very little faunal turnover occurred. The chronostratigraphic control on this transition is very good, especially in Trans-Pecos Texas, where there is very little difference between the late Duchesnean Porvenir local fauna (which overlies an ash dated 37.8 ± 0.15 Ma by 40Ar/39Ar) and the overlying early Chadronian Little Egypt local fauna (which is overlain by a tuff dated 36.7 ± 0.07 Ma by 40Ar/39Ar). Most Porvenir genera continue right on through the Chadronian.

The earliest Oligocene (33 Ma, mid-Chron C13n) event was one of the most severe climatic events of the Cenozoic. According to Wolfe's (1978, 1994) leaf-margin analysis, mean temperatures dropped by 13°C, and conditions became much more dry and seasonal. This is supported by the sedimentology (from floodplain to eolian), paleosols (from forests to open scrub), land snails (from tropical to dry-temperate), and reptiles and amphibians (aquatic turtles, crocodilians, and salamanders replaced by land tortoises). This dramatic climatic change occurs in the middle early Orellan, a period of great faunal stability, when 62 out of 70 species continue right through the climatic change with no visible signs of change.

Carbon isotopic studies have shown that C4 grasslands developed worldwide in the late Miocene (about 7 Ma). But in North America, mammalian diversity declined only slightly from the early Hemphillian (9-7 Ma) and the late Hemphillian (7-5 Ma), and there was no noticeable increase in grazing taxa. Similar observations have been made for the mammalian faunas in the late Miocene of the Siwaliks in Pakistan, and for East Africa.

Neo-Darwinian theory has long preached than animals are infinitely responsive to changes in their environment, but in three of the best-documented and most severe environmental changes in the entire Cenozoic, the mammalian faunas show virtually no response. Stability and resistance to change goes well beyond the level of species, to entire integrated faunal associations that are very resistant to even the most severe climatic events.